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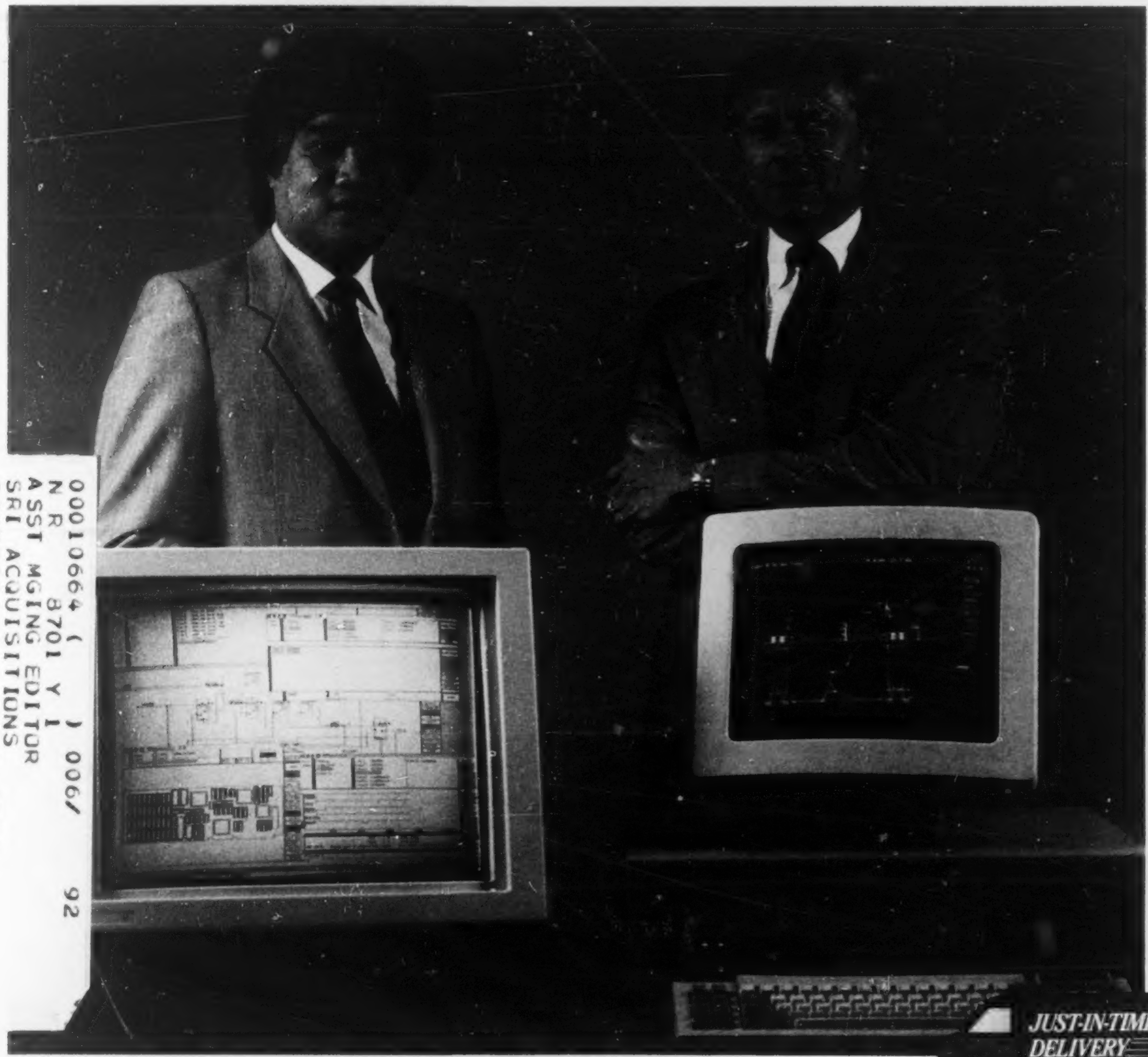
Electronic Business

Japan at the crossroads: A new chance for U.S. high tech

In search of ISDN, the Integrated Services Digital Network



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JUST-IN-TIME DELIVERY

Electronics Factory of the Future

Bernard Tse and Phillip White: A couple of Wyse guys make good in terminals

Electronic Business

VOL. 12, NO. 21

NOVEMBER 1, 1986

THE BUSINESS MAGAZINE FOR THE ELECTRONICS INDUSTRY

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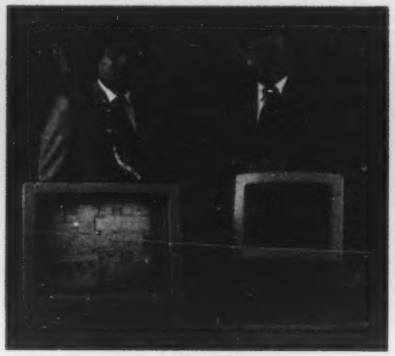

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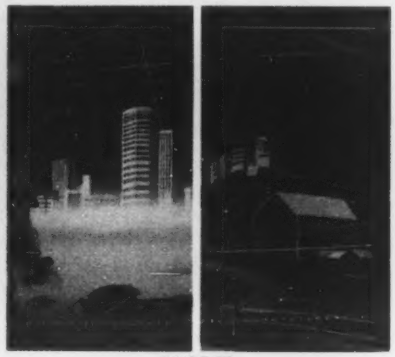

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Cover photo: Robert Isaacs

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BPA ABP

Industrial distribution sales grow, but not from chips

Growth comes from computers, connectors, instruments. Low EPROM prices don't help

"AMD's accounting policy recognizes [shipments to industrial distributors] as sales only after the distributor resells the products." So wrote Advanced Micro Devices Inc. chairman W.J. Sanders III, in the company's report for the second calendar quarter of 1986, to explain why AMD's sales did not keep pace with the recovery that began (for his company) in the autumn of 1985. "Much of the product [we] shipped to distributors in June remained on their shelves," explained Sanders. He and his distributors had expected better. "Based upon the strength of orders placed with us by distributors, we had anticipated a significant increase," laments Sanders in his report.

Other semiconductor manufacturers have seen the same problem in distribution sales that affected AMD. According to the Semiconductor Industry Association (SIA), sales to U.S. distributors peaked last April at 28% but have been declining since, both in dollar volume and as a percentage of sales by chip makers to the U.S. market. Distributors are, as Sanders points out, overstocked with semiconductors. To trim their inventories, they have cut orders for semiconductors so much that they dragged the SIA's book-to-bill ratio below unity last July.

On the other hand, distributors did better with products other than with semiconductors. According to the National Electronic Distributors Association (NEDA), shipments by U.S. industrial electronics distributors last June reached the highest level since September 1984. NEDA's estimate is based on a sample of companies which includes six of the top 10 distributors and represents almost half of the total dollar sales. But they have trimmed orders for chips because their own books have been filling more slowly since March.

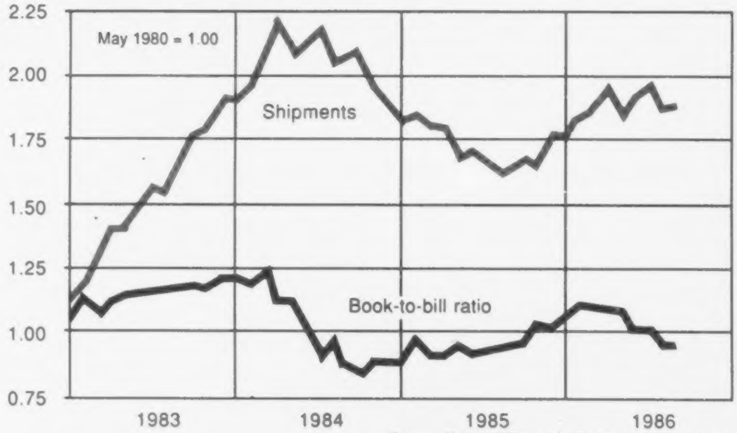
Although there are few bright spots in distribution, it continues to grow. The NEDA index for shipments shows that distributors' sales in the first half of this year were 13% higher than sales for the same period last year and lagged by only 10% from the record first half of 1984.

Part of the activity comes from connectors, as chairman Tony Hamilton of the No. 1 distributor, the Electronic Marketing Group of Avnet Inc., pointed out last month in his keynote speech at the Connectors and Interconnection Technology symposium — the major annual forum organized by connector users. The activity in military electronics and in avionics has created a steady (military and commercial) demand this year for high-quality connectors and interconnection components which command high prices and provide high margins. Between its two major distributors, Hamilton/Avnet and Time Electronics, Avnet's EMG will ring up almost half billion dollars this year in sales.

Another distribution item that is still small but whose growth has helped distributors' shipments this year is electronic instruments. NEDA estimates that distributors which specialize in this area sold $140 million worth of electronic test and measurement equipment in 1985.

ALBERTO SOCOLOVSKY

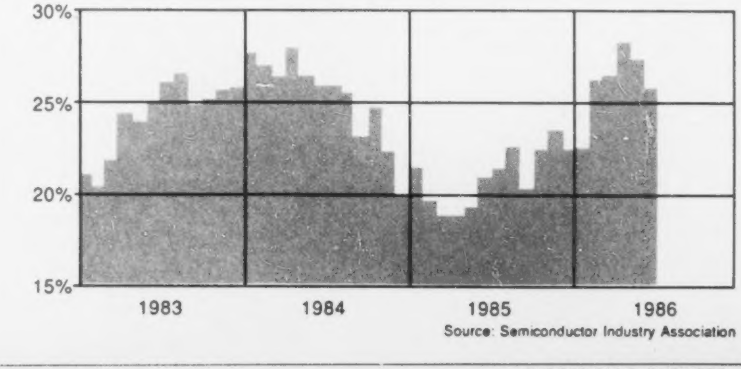
Distribution business index



Source: National Electronic Distributors Association

Distributors' share of IC shipments

(Percentage of U.S./Canadian shipments)



Source: Semiconductor Industry Association

Slower growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, was up a slight 1.1% annualized rate in the first quarter of this year. Mild declines are expected in the second and third quarters, with a turnaround starting in the fourth quarter. For the year, production is expected to be up a scant 0.3% from last year.

The Cahners Early Warning Indicator (CEWI) is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index. It forecasts probable business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 100.3 level forecasts using the CEWI for the end of this year indicates that the average for all of 1986 should be 0.3% above 1985.

Readers can obtain a brochure explaining the CEWI method from Cheryl Patstone, economist, Cahners Economics Department, 3021 Tisch Way, Suite 100, San Jose, Calif., 95128.

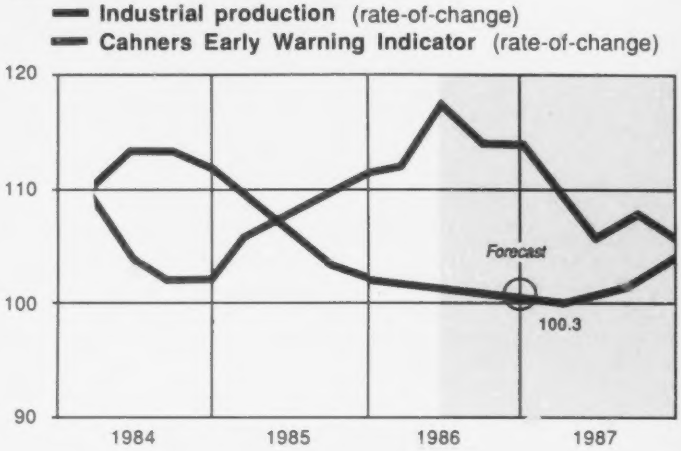
Electronic components

Component manufacturers scaled back production steadily in the second quarter. As a result, output at midyear stood at the lowest level in nearly three years and was off more than 20% from the peak rate in the summer of 1984. On a brighter note, the margin of year-to-year loss has narrowed steadily over the course of 1986, suggesting that better times are ahead. If orders show their traditional seasonal improvement in the fourth quarter, then production activity is likely to show a corresponding upswing toward year's end. We expect an overall 7.8% real decline in output for 1986, followed by gains of 10.8% next year and about 23.8% in 1988.

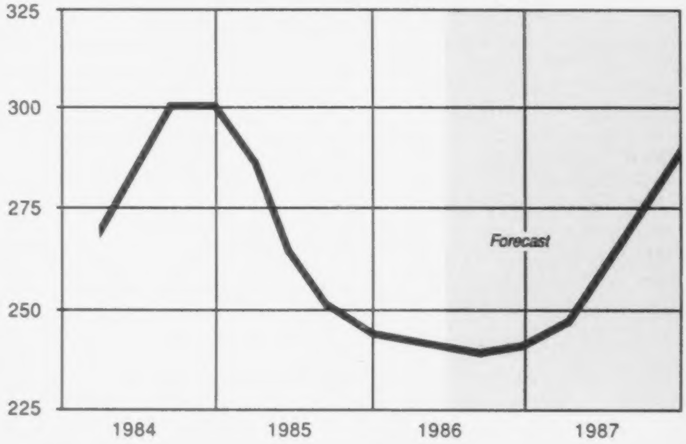
Equipment, instruments and parts

Instrument production slackened in June, but the entire second quarter still showed an increase of about 1% over the first quarter pace. This year's declines in U.S. capital investment have weighed down many segments of the industry, such as scientific and engineering instruments and factory automation. But medical and consumer products have been unaffected by the drop in investment spending and have helped to prop up the industry. Production will continue to inch upward, over the balance of this year, achieving an annual gain of 2.9%. Look for a rebound in the capital equipment markets to bring subsequent increases of 3.2% in 1987 and 9.8% in 1988.

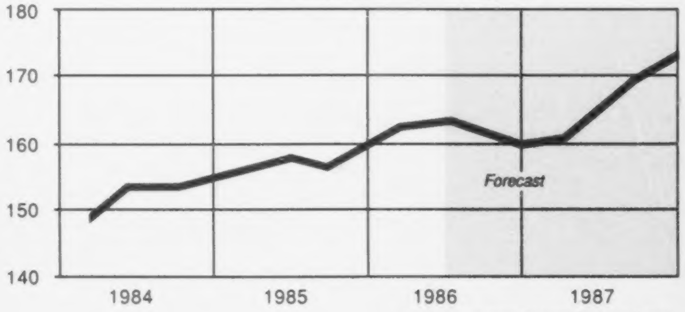
Economic indicators



Industrial production: Electronic components
(1977 = 100, quarterly averages)



Industrial production: Equipment, instruments and parts
(1977 = 100, quarterly averages)



Historical data: Federal Reserve Board
Forecast: Cahners Economics

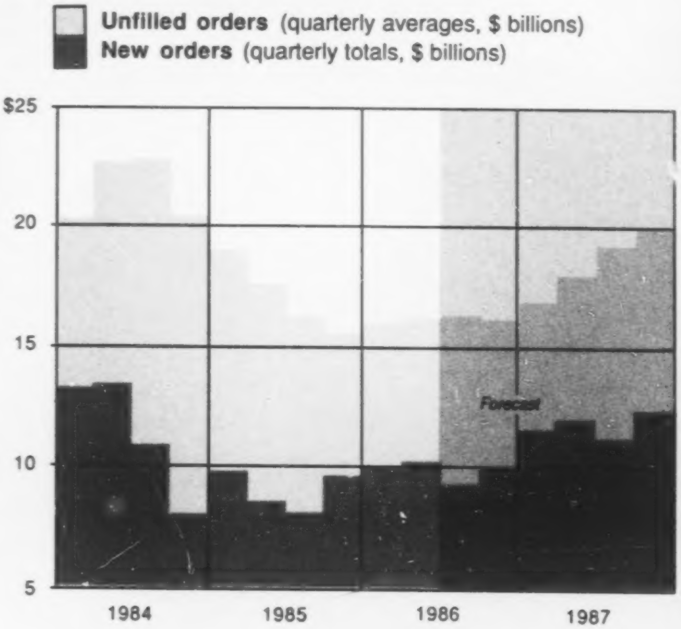
Electronic components (SIC 367)

New orders
Component manufacturers received $10.17 billion worth of orders in this year's second quarter, an increase of 3.0% over the total for the prior three months and up 20.1% compared to the second quarter of 1985. But the industry's strength faded toward midyear when economic growth slowed to a crawl, causing order rates to fall back more than usual in the seasonally sluggish third quarter. Demand is expected to begin improving again toward year's end, with a gradual uptrend over the course of 1987. After falling 20.7% in 1985, orders are forecasted to increase 9.4% to $39.3 billion this year, 19.0% next year, and 23.2% more in 1988.

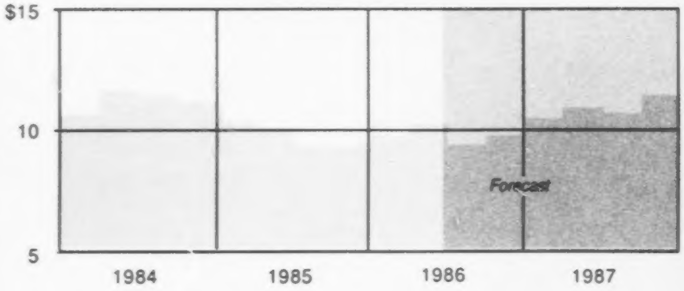
Unfilled orders
Manufacturers' order backlogs averaged $16.1 billion in the second quarter. This represents a slight increase over the first quarter but a decrease of more than 8% from the second quarter of 1985. A midyear drop-off in component demand will prevent backlogs from increasing over the next several months. However, they should begin to expand again by early 1987, finishing next year more than 20% ahead of the late 1986 level. Unfilled orders are expected to decrease 5.7% this year, followed by gains of 14.2% and 28.1% in 1987 and 1988, respectively.

Shipments
Component manufacturers shipped $10.18 billion worth of products in this year's second quarter, an increase of about 1.1% over the total for the same period of 1985. This was the strongest level of market activity in more than a year and came in response to the brisk increase in orders between August of 1985 and March of 1986. The market reversed direction this summer and will improve only slightly during the fourth quarter, held back by the recent slump in orders. As a result, shipments are expected to grow just 0.9% to $39.2 billion this year, followed by gains of 11.3% in 1987 and 18.9% in 1988. These performances compare to a sharp 13.4% loss in 1985.

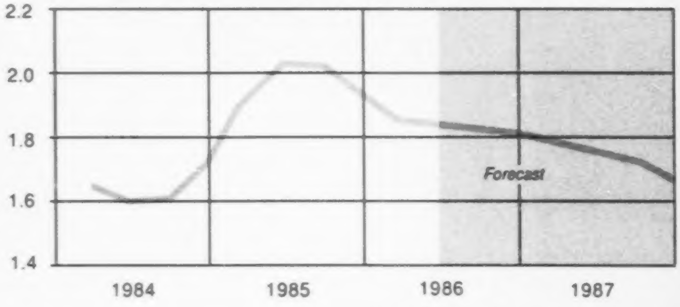
Inventory-to-shipment ratio
The component industry's ratio of inventories to shipments was 1.83 in the second quarter, unchanged from the level in the first three months of this year. This was near the upper limit of the 1.75 to 1.85 range which was previously expected for 1986. A slackening in both shipments and inventories during the second half of this year should keep the I/S ratio balanced near its current level. Improved shipment activity in 1987 and 1988 is expected to pull the ratio downward. The I/S ratio should reach about 1.65 by the end of next year and could break below 1.6 in late 1988.



Electronic components: Shipments
(quarterly totals, $ billions)



Electronic components: Inventory-to-shipment ratio
(seasonally adjusted, quarterly averages)



Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

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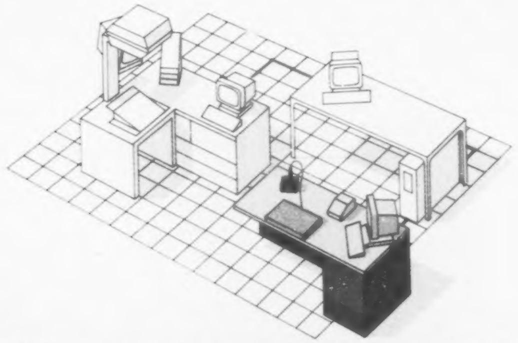

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LETTERS

A worthy review

I thought your review of An Wang's autobiography [Sept. 15, p148] was exceptionally good. Not only did you provide a good idea of what the book is about, but you added an up-to-the-minute update on the fortunes of Wang and his company. I can't think of another reviewer who could have done it as well. Congratulations.

LON CANTOR
Director Communications & Advertising
RCA
Somerville, N.J.

Correction

The article on 3.5-inch and 5.25-inch disk drives [ELECTRONIC BUSINESS, August 1, 1986, p81] included last year's market forecasts for sales of floppy disk drives in North America. ELECTRONIC BUSINESS apologizes for publishing the data which, unknown to us, had already been revised. The newly revised projections for that market indicate the following:

	5.25-inch drives (Units, in millions)	3- to 3.5-inch drives (Units, in thousands)
1984	7.69	272.0
1985	8.26	603.0
1986	10.03	890.0
1987	11.06	2,100.0
1988	10.53	4,785.0
1989	9.47	8,040.0

Source: Dataquest Inc.

Correction

In the September 15 issue of ELECTRONIC BUSINESS in an article entitled "PCB CAD: More slices from a larger pie," the magazine incorrectly reported that Vectron Graphic Systems had gone out of business. Vectron Graphic Systems continues to operate under Chapter 11 of the U.S. bankruptcy code.

Letters to the editor

ELECTRONIC BUSINESS welcomes letters to the editor on any topic of interest to our readers. If not written on organizational letterhead, all letters must include a telephone number. ELECTRONIC BUSINESS reserves the right to edit letters.

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Stephen Levy: Restoring manufacturing vitality

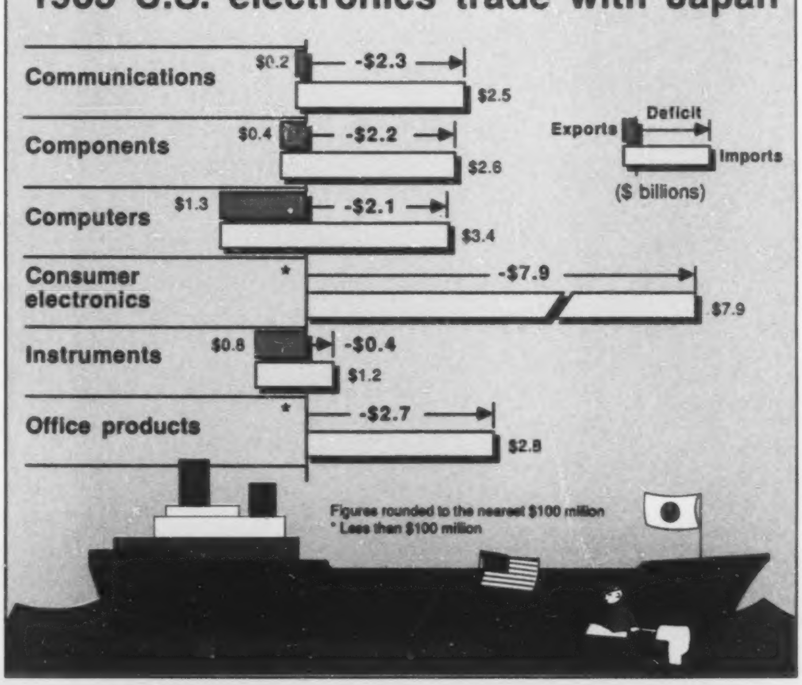
The outgoing chairman of the AEA outlines his views on trade, industrial policy and tax reform

Stephen R. Levy, chairman and chief executive of Bolt, Beranek and Newman Inc. has served as chairman of the American Electronics Association (AEA) during 1986. Levy, 46, has sought to focus AEA attention and resources on the issue of the declining international competitiveness of U.S. manufacturers. Levy said his efforts have involved "making our members aware of the problem and engaging them in the effort to reverse the decline." Levy contends that the U.S. government, which often bases its decisions on military and geopolitical concerns, must begin making decisions geared toward restoring this country's manufacturing vitality. During more than two hours of interviews with senior editor Norm Alster, Levy outlined his views on trade, industrial policy, tax reform and Japanese business practices. Here are excerpts from Levy's comments:

1. On the U.S. trade deficit with Japan:

"Our country cannot address the bilateral trade problem with Japan without addressing electronics and automobiles. Electronics and automobiles each account for roughly one-third of the bilateral trade deficit. Unfortunately, the electronics trade deficit is growing faster than any other part of the trade deficit and it's not confined to consumer electronics. It's extending to industrial electronics as well: components, telecommunications, office automation products, instrumentation. Virtually every aspect of the electronics industry has experienced erosion over the last five years in terms of its bilateral trade with Japan. The fact of the matter is we import, as a nation, nearly $21 billion of electronics goods from Japan and we export $3 billion to them. It's hard to understand why, with the strength of the U.S. electronics industry, we've been so unsuccessful."

1985 U.S. electronics trade with Japan



Figures rounded to the nearest $100 million
* Less than $100 million

2. On restoring U.S. industrial competitiveness:

"First, we must develop policies that encourage savings and investment. We must improve and expand our capacity to create and apply technology through adequate investment in R&D [research and development] and plant and equipment and by enhancing the technology training and skills of our citizenry. Right now, the level of U.S. investment in manufacturing plant and equipment per year, per employee, runs about one-third of the Japanese level of investment. We need increased investment in plant and equipment and expanded investment in the training and education of our people. Then we have to enforce trade laws and provide improved protection for intellectual property. And finally, we have to make trade a national priority and give it equal status with defense and state."

3. On the ability of the U.S. government and public to focus on rebuilding America's manufacturing base:

"The issues are very deep. It's taken us 10 or 15 years to work ourselves into our current problems. It's going to take a decade for us to work ourselves out of them. . . . The U.S. has a great capacity for change. We can do polarity shifts faster than anyone in the world. Usually, it takes a crisis to produce a polarity shift. We did, for example, change our habits in a fundamental way as far as energy was concerned. Today, we are producing 35% more goods and services than in 1973 with almost exactly the same consumption of energy. . . . You have to acknowledge the problem. You have to set goals. I believe restoring the competitiveness of our manufacturing industries should be a national goal. Then you have to set objectives that allow you to measure your progress toward meeting that goal. I think a reasonable goal is to restore U.S. manufacturing to competitiveness as measured by a balance of trade in manufacturing goods by the early 1990s. That will take a lot of work. But with a goal and objectives, our country can adopt the proper policies."

4. On trade and national defense:

"As a nation, we have to make trade a national priority. It is not a priority today. It takes a backseat to matters of state and defense. . . . We've got 6.5% of our gross national product in defense. They [Japan] spend 1%. They are the beneficiaries [of our defense spending]. With that 5.5% difference, Japan has $100 billion that it can allocate differently. We've decided to put it into defense. They have decided, I believe, to achieve domination in the Information Age comparable to the domination they feel the U.S. had in the Industrial Age. . . . We cannot have a strong national defense without a strong economy. And we can't have a strong economy without a strong manufacturing industry."

5. On lowering the cost of capital for U.S. manufacturers:

"A principal determinant of the cost of capital is the savings rate, which drives interest rates. The Japanese savings rate is four or five times our savings rate. They have, in effect, a surplus of savings. That surplus of savings drives down their interest rates. . . . Part of the reason that our cost of capital is so high is that we have fiscal policies — budget deficits — that are much too high. The nation is spending far too much in relationship to what it produces. Our tax and credit policies encourage consumption instead of saving. We need greater savings to keep our interest costs down and to improve our capital formation."

6. On the new tax reform legislation:

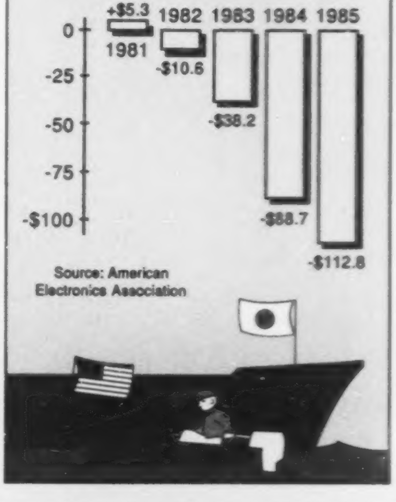
"I would have liked to have seen more to encourage savings and investment. I would have liked preservation of the capital gains differential. I would have liked the exemption of savings from taxation up to a certain amount for all individuals. Those kinds of modifications in the tax code would have been more in line with what we've encouraged to improve

AEA CHAIRMAN STEPHEN LEVY: "We have to make trade a national priority"

competitiveness. . . . On the positive side, certainly within the industrial sector, the tax bill has served to level the playing field. Since profitable high-technology companies tend to pay at or near the statutory rate, the rate reduction will generally make profitable high-technology companies net beneficiaries. There's also some benefit in the preservation — although on a scaled-back basis — of the R&D tax credit. But when all is said and done this tax bill does add $120 billion to corporate taxes and transfers the benefits through the lowering of personal taxes. The increase in corporate taxes cannot be good for industry in general. Even though we in high technology may be beneficiaries, the people we sell to are the ones who are seeing their tax bills go up."

U.S. manufacturing in decline: From surplus to $112.8 billion deficit in five years

U.S. manufactured goods trade balance ($ billions)



Source: American Electronics Association

7. On Japanese business practices:

"I have great admiration for Japan and the Japanese people and what they've accomplished. It's difficult for me as an American to denigrate in any way a people who work hard, who save a lot of what they earn, who value quality, who value education. The fact that the Japanese have been successful in improving the standard of living of their people is something we should applaud . . . and I believe the Japanese do scrupulously adhere to the terms of agreements they reach. But I also believe they operate with a clearer consensus as to what their national goals and objectives are and adopt policies and practices that are consistent with those goals and objectives. And some of those policies and practices violate the spirit, if not the letter, of trade agreements and trade laws that we have and that exist around the world. These practices include targeting, dumping and the exclusion of foreign manufacturers from their domestic markets. [Levy then talks about Japan's technology acquisition practices.]

"There's another thing they've done which I wouldn't say actually violates patent laws, but, if they believe a particular company or country is ahead of them in some particular area, they will try to get that technology. They are prodigious collectors of information, analyzers and distributors of information. They've used licensing agreements and joint ventures very effectively. They have, for a number of years, precluded entry into their market by a foreign company, unless that company did it through a joint venture that allowed the Japanese partner to acquire the skills and knowledge about that particular technology. And once they did and built their own skills, often those joint ventures were dissolved."

8. On the impact of the yen's appreciation on Japanese manufacturers:

"Japanese companies have been forced to accept smaller profit margins because they were unwilling to pass on price increases that might cost them market share, particularly in relationship to consumer electronics. The Koreans have been one of the beneficiaries of this realignment in currencies. They've picked up a 40% currency advantage over Japan. To the extent that the Japanese companies raise prices, they will in effect provide a pricing umbrella for Korea and Hong Kong and, to some extent, Taiwan, to come in under. Clearly, what's happened is there has to have been some pressure on their profit margins or they've had to improve their manufacturing efficiencies. And they've had a short period of time in which to do that. More likely — and you see every evidence of it — they've been willing to accept smaller margins. And how long can they continue to accept smaller margins?" □

Expert systems: Finding applications in electronics

The $140-million expert system market is still in the development stages, with lots of activity in prototyping

Expert systems — the artificial-intelligence (AI) software programs which do everything from configure computer systems to monitor soup cookers — are the best known segment of AI. The early leaders in expert system development and installation are well-established giants: AT&T, Digital Equipment Corp., Honeywell Inc., IBM, Sperry Corp. and Texas Instruments Inc.

But now, it seems, almost every other major electronics company, and some minor ones, have also gotten into the expert system act. Between February and August of this year, the number of known expert systems employed within *Fortune* 1000 corporations rose from 50 to 150, according to Paul Harmon, editor of "Expert Systems Strategies," a San Francisco-based newsletter. And for every known expert system used at a major corporation, he maintains, there are eight or nine other expert systems that the *Fortune* 1000 crowd considers too sensitive to divulge. By the end of the year, however, the number of routinely discussed expert systems will be pushing 1,000, Harmon predicts.

As a result, expert systems are the most profitable type of AI software. By the end of 1986, expert systems revenue will reach $140 million, representing 13% of this year's total $1 billion AI-hardware and -software market, according to D.M. Data Inc. (Sales of AI hardware that is used to develop and deliver AI software comprise roughly 50% of the total AI market.) By 1990, the market for expert-system tools and complete systems will reach $810 million, the Scottsdale, Arizona-based market research firm claims.

Currently, most expert systems are based on small- to medium-sized software programs which take between three months to a year to develop. The majority of existing systems were developed for in-house use only in areas such as diagnostics, maintenance and troubleshooting. Half of all expert systems are custom-designed from scratch, according to D.M. Data analyst Harvey Newquist. Forty-five percent of them use some type of frame-

A sampling of electronics-related expert systems

Name of system	Developer and/or owner	Domain and task	Usage
ACE	Bell Labs (AT&T)	Troubleshoots cable systems and recommends maintenance	Internal
BDS	Lockheed	Troubleshoots communication hardware	Internal
BEACON	Burroughs	Configures Burroughs computers	Internal
Capital Asset Process Advisor	IBM	Assists in developing procedures for moving capital equipment	Internal
COCOMO1	Level Five Research	Assists in planning and scheduling software development	For sale
COMPASS	GTE	Troubleshoots telephone-switching equipment	Internal
CONAD	Nixdorf	Checks orders and configures Nixdorf computers	Internal
CSF Advisor	IBM	Guides development of cost estimate for moving DP equipment	For sale
DART	IBM	Diagnoses computer faults	Internal
DIA 8100	Teknowledge for Traveler's Insurance	Diagnoses failures of DP equipment	Internal
Dispatcher	DEC	Assists in maintaining inventory records	Internal
DRAGON	Systems Designers Software for ICL	Configures orders for ICL's Series 39 computers	Internal
ESPm	NCR	Analyzes computer maintenance logs to identify future faults	Internal

(Table continued on page 34)

sor. The tutor teaches scope customers how to use the oscilloscope.

Meanwhile, Ford Motor Co. is working on a similar computer-aided instruction project. Using Texas Instruments' Personal Consultant expert-system building package for personal computers, Ford built a diagnostic expert system for its robotic equipment. It reportedly has shipped to all of its robotics vendors, who use the expert system to take them step-by-step through diagnostic routines. Previously, operators had to diagnose a robot malfunction using pages and pages of documentation.

Honeywell Inc. in Minneapolis has also implemented several expert systems. One, called the Intelligent Software Configurator, helps customer-service engineers install computer systems. The other, PAGE-1, is a troubleshooter for its top-of-the-line page printer. The systems, developed concurrently using Xerox 1100 AI workstations and the Interlisp and Loops programming aids, took about a year to devise, according to Barbara Braden, manager of advanced technology for the customer services division. The company is also looking at expert systems for troubleshooting disk drives, identifying software problems and other applications.

Once a company starts looking for ways to use expert systems to solve problems, analysts say, it is only a matter of time before a potential application is found. "We've seen quite a number of projects that were done because someone else proved it could be done," newsletter editor Harmon says. Indeed, almost every computer company involved in AI has built and deployed remarkably similar configurators, troubleshooters and the like.

The result is a shotgun approach to AI, involving numerous applications. This month NCR Corp. of Dayton, Ohio, for example, is slated to deploy an innovative system called ESPm, short for Expert System for Preventative Maintenance. While other expert systems suggest hardware repairs only after a system is down, ESPm alerts customer service representatives of potential problems, based on the unusual events recorded in the daily logs of NCR's 9300 superminis. The system, which runs on NCR Tower superminis, took two years to build using Teknowledge's S.1 shell, says Nelson Hazeltine, NCR's acting director of advanced software technologies. The system is one of 17 expert systems currently in place at NCR.

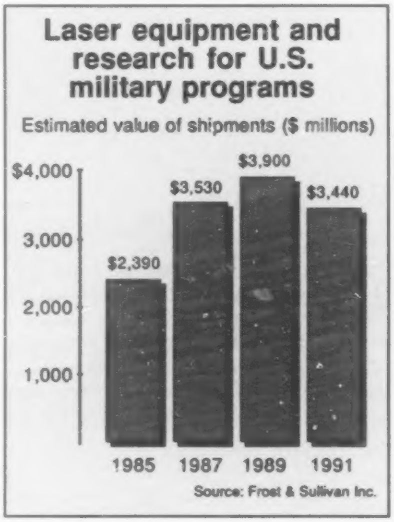
MARY JO FOLEY

Electronic warfare: Laser market still shows luster

"Star Wars" may grab the headlines, but the market for ground-based laser systems is where all the action is

Despite talk of strategic defense and a space-based laser bulwark against ballistic missiles, the bulk of the money spent on military lasers still goes for ground-based systems. That is good news for manufacturers of defense electronics gear, many of whom are worried that political opposition to President Reagan's Strategic Defense Initiative (SDI) may one day blast it out of the political skies.

First used in the Vietnam War to guide bombs to their targets, lasers have become an integral part of many so-called "smart weapons" in today's electronic warfare arsenal. They are used in fire-control systems for jetfighters, navigation devices for helicopters and as precise guidance for artillery and missiles.


Laser equipment and research for U.S. military programs

Estimated value of shipments ($ millions)

Source: Frost & Sullivan Inc.

Tactical or nonnuclear programs account for about two-thirds of the $3.2 billion in fiscal year 1986 expenditures for lasers — with missile guidance leading aircraft navigation and battlefield surveillance systems, according to a recent report by by Frost & Sullivan Inc., an international market research firm.

Lasers have two principal military uses in tactical warfare. One is to illuminate targets which can then be hit with a variety of missiles and artillery shells. The other is as a range finder to provide accurate measurements for navigation of vehicles, helicopters and planes.

"The laser illuminates the target and the missile receives the reflected energy," says Seymour Zeiberg, vice president of technical operations at Martin Marietta Corp.'s aerospace operations in Orlando, Fla. "Or you shoot out a beam and receive very, very precise measurements."

At $798 million in reports for fiscal year 1986, missile programs make up about one-fourth of the total laser market, with aircraft programs accounting for $691 million and battlefield programs at $621 million. Army weapons programs dominate the missile sector, Frost & Sullivan says, with the single largest item being the laser-guided Hellfire missile. The Copperhead missile's laser-guided artillery round is also a major recipient of Pentagon dollars.

Martin Marietta is the prime contractor for both Hellfire and Copperhead. In fiscal year 1985, the company had 18.6% of the military laser market, followed closely by Hughes Aircraft Co. at 17.6%. Rockwell International Corp. was a distant third with 6.7%.

Leave it to Litton

The preeminence of Martin is ironic in that the Bethesda, Maryland-based electronic warfare supplier no longer makes lasers. Indeed, it integrates lasers it buys from other suppliers at its operation in Orlando. Many of its lasers come from Litton Industries Inc.'s Laser Systems unit, the Orlando-based arm of the defense and technology conglomerate located in Beverly Hills, Calif.

Litton Lasers' vice president of business development, J.J. Battaglia, says the company expects "a very comfortable growth rate without dipping into SDI work. We have sort of become predominant in the tactical arena." Litton does not break out revenue for individual groups but the Orlando division does "in excess of

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$20 million annually," says president Maurice R. "Bud" Yeager.

Four Martin programs — the Hellfire, Copperhead, the Lantirn night-targeting and vision system for the F-16, and Apache helicopter — accounted for about $1 billion in sales last year for Martin's Orlando division. The lasers, however, are only a very small part of each complex weapons system.

"There are a variety of smart munitions, but one component of that is the laser-guided weapon," says William Schwartz, who helped direct Martin's laser work before forming his own company, International Laser Systems Inc., and then selling it to Litton in May 1983.

Lasers have their limits, though. Operating one can be a dangerous experience. The user risks the threat of eye damage, or worse, the possibility of being killed by an enemy round. Laser operators often have to assume positions forward of tanks and other battlefield vehicles. To combat these problems, laser companies are working to develop lasers that are less harmful to the eye and ways to shield laser operators from enemy attack, such as placing them inside armored vehicles or eliminating the user altogether, as is the case with the remotely piloted Aquila drone.

Martin recently received a $17.9 million research contract to build a prototype elevated targeting and acquisition system, which might position a laser atop a 50-foot telescopic pole mounted on an armored vehicle. The concept is similar to that already in use on scout helicopters, where the laser is mounted on the tip of the rotor.

Despite the current emphasis on ground-based systems, it is the dream of building a wall in space to deter enemy nuclear missiles that will drive the military laser market in future years, Frost & Sullivan says.

"Laser-designating guidance as a firm technique for precision-guided munitions show signs of slowing down," says Frank Meyer, Frost & Sullivan's project director. "Procurement gaps are evident in all branches of the armed forces, both in the equipment carrying laser designators and in the laser-designation method for targeting."

Still, laser marketers like Litton's Battaglia point out that many existing weapons systems — the Apache attack helicopter being one example — are set for upgrades and that could involve the improvement of the laser.

TIM SMART

Suppliers to the U.S. military laser market

Estimated value of fiscal 1985 U.S. shipments

Supplier	Value ($ millions)	Market share
Martin Marietta	$444	18.6%
Hughes Aircraft	420	17.6%
Rockwell	161	6.7%
Texas Instruments	145	6.1%
Litton Industries	89	3.7%
Kollsman Instrument	77	3.2%
McDonnell Douglas	75	3.1%
Loral Electro-Optical	74	3.1%
TRW	66	2.8%
Los Alamos Laboratory	65	2.7%
Lockheed Missiles	63	2.6%
Livermore Laboratory	61	2.6%
Emerson Electric	49	2.1%
Avco Textron	48	2.0%
Northrop	29	1.2%
Perkin-Elmer	25	1.0%
Ford Aerospace	24	1.0%
BDM	22	0.9%
Draper Laboratory	18	0.8%
Boeing Aerospace	13	0.5%
Westinghouse Electric	12	0.5%
LTV Aerospace	11	0.5%
Optic-Electronic	10	0.4%
United Technologies	$9	0.4%
General Dynamics	8	0.3%
Penole	6	0.3%
Schafer Associates	6	0.3%
Science Applications	6	0.3%
Sperry	6	0.3%
R&D Associates	4	0.2%
RCA Automated Systems	4	0.2%
Singer Kearfott	4	0.2%
Teledyne Brown	4	0.2%
GTE Electro-Optics	3	0.1%
Honeywell	3	0.1%
MIT Lincoln Laboratory	3	0.1%
Sanders Associates	3	0.1%
Sandia Laboratories	3	0.1%
Stanford University	3	0.1%
Aerospace	2	0.1%
Arvin Calspan	2	0.1%
Eastman Kodak	2	0.1%
Western Research	2	0.1%
Other	306	12.8%
Total market	**$2,390**	**100%**

Source: Frost & Sullivan Inc.

Japanese printer makers look for ways to cut costs

The disparity between the dollar and the yen is forcing Japanese printer manufacturers to rethink their strategies

The value of the dollar against the yen has dropped more than 60% in the past year, but so far Japanese manufacturers have been able to hold price increases on serial and line printers to between 5% and 10%. Vendors claim that they have been able to do this by introducing new models with higher price performance.

Profit margins, however, are under severe pressure. As a result, many vendors are scrambling to find new ways to reduce costs.

The OKI Data Group of OKI America Inc., for example, has resorted to containerization to help reduce trans-Pacific shipping costs. The parent company in Japan is also continuing to invest heavily in automation, according to James Cullen, OKI Data's director of marketing in Mount Laurel, N.J. Smart as Oki is, Cullen adds, the company would be remiss if it it were not looking at the possibility of shifting some Japanese production offshore to cheaper labor markets in Southeast Asia.

In addition, other firms are emphasizing more standardized componentry. Clearly the intent is "to cut out the [more costly] human interface as much as possible," comments Bhanu Bhattasali, a printer analyst at Dataquest Inc. in San Jose, Calif.

Meanwhile, state side subsidiaries are being asked to hold the line on sales costs and re-examine spending. "In the U.S. we've maintained the status quo in fixed costs for sales and distribution even though sales have increased," reports Andrew Leonard, vice president of marketing for Epson America in Torrance, Calif., part of Seiko Epson Corp.

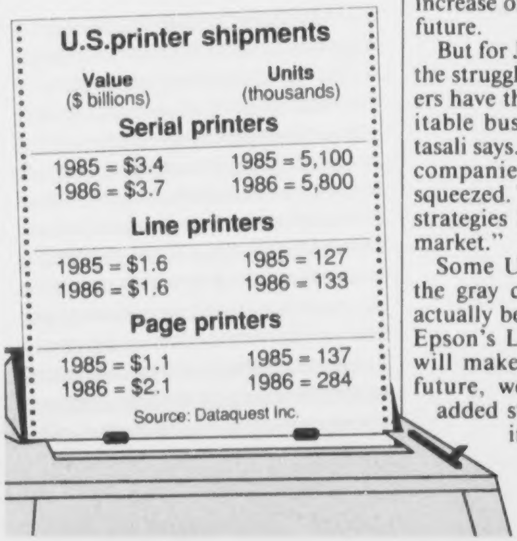
Can Brother spare a dime?

Brother International Corp., Piscataway, N.J., meanwhile is redoing budgets for trade shows, salaries, commissions and advertising. In some cases, it has even arranged for products to be shipped directly from the factory to large accounts. "It eliminates our warehousing costs and we're able to pass that on to our accounts," Alex Schibanoff, operations manager for Brother's Information Systems and Peripherals division, says.

Some printer makers are also building or planning to build plants in the United States. The move may primarily be a hedge against the threat of increased duties on Japanese goods, but it also promises to cut manufacturing costs and speed up turnaround — the time it takes between when an order is received and when a customer receives the finished product.

NEC, for example, which manufactures 30% to 40% of its printer accessories in the United States, is in the midst of moving printer manufacturing here. John McIntyre, product manager for serial and line printers at the $300 million firm, says that the move will take "a number of years" to accomplish. Meanwhile, "a consumables line is a key element in a company's financial strength, and our capability to source in the U.S. helps us a little," he says.

Epson, too, has opened a printer plant in Portland, Ore., partly "for cost reasons, but [also] for shorter turnaround to meet demand, and to have a U.S. presence," Leonard says. And Brother is also looking for a site in the United States to manufacture typewriters initially, and other products, possibly including printers, to follow. The diversified electronics company currently manufactures typewriters in Brazil and sewing machines in Ireland, but so far it does not source printer parts outside of Japan.



U.S.printer shipments

Value ($ billions)	Units (thousands)
Serial printers	
1985 = $3.4	1985 = 5,100
1986 = $3.7	1986 = 5,800
Line printers	
1985 = $1.6	1985 = 127
1986 = $1.6	1986 = 133
Page printers	
1985 = $1.1	1985 = 137
1986 = $2.1	1986 = 284

Source: Dataquest Inc.

Meanwhile, American printer makers — including Hewlett-Packard Co., IBM and Xerox Corp. are capitalizing on the strong yen to gain ground, particularly in the higher priced line and page printer market segments. Xerox of Stamford, Conn., for example, reports it has not raised or lowered prices all year. "We've been at a price disadvantage against the Japanese until now and this is restoring parity. In the past we've struggled with the strong dollar. This equalizes things," says Michael Winkler, vice president of Xerox's centralized strategic business unit. The company, which saw printer revenue rise 50% in 1985, says that printers account for about 15% of total income. This fall, Xerox will begin augmenting sales of low-end products through its dedicated salesforce with distribution through retailers, distributors, value-added resellers and other channels.

One problem U.S. vendors have, however, is that many of them source Japanese componentry from Japan. Like many other American printer makers, Hewlett-Packard, for example, uses Canon engines in its printers, and as the price of those engines increases, that puts pressure on U.S.-built machines. "The value of our dollar is decreasing for the price we have to buy engines," a Hewlett-Packard official concedes. But the company says that it has no plan to either increase or decrease prices in the near future.

But for Japanese printer companies, the struggle goes on. "The major players have the volume to sustain a profitable business," Dataquest's Bhattasali says. "It's the smaller [Japanese] companies that are likely to get squeezed. They'll have to rethink their strategies if they want to stay in this market."

Some U.S. companies even think the gray cloud of a strong yen may actually be hiding a silver lining. Says Epson's Leonard: "Ultimately, this will make us more efficient. In the future, we'll look toward a value-added strategy rather than answering every competitive foray with a price move."

MICHELLE VRANIZAN

Vranizan is a Los Angeles-based business writer

ATMs: A fast-growth market flattens out

The automatic teller machine market may be reaching maturity, as banks tighten up on capital expenditures

The market for computerized automated teller machines (ATMs), a high-growth market in the early 1980s, is suddenly quite flat. In 1985, U.S. shipments totaled 8,343 units, down from nearly 14,000 in 1983, according to Linda Zimmer, a Marlborough, Connecticut-based independent analyst. And most industry sources agree that the market will be lucky if it is able to top that 1985 figure by year-end.

What has happened to dampen the spirits of the ATM market which just three years ago was boasting shipments of almost 14,000?

Vendors and analysts believe one of the major problems affecting the ATM market has been tighter controls on expenses. ATMs run about $30,000 each, and including the cost of installation and service contracts, a bank can spend as much as $75,000 to set up one machine. In these days of declining interest rates, while banks are trying to find ways to boost their profits, the flip side of the coin is controlling expenses.

But more importantly, banks which have installed ATMs over the past few years have not yet been able to get customers to use the machines in large enough volume to make it a cost-effective tool. "Huge numbers of ATMs were installed because of the network explosion, but there was no marketing to follow suit," analyst Zimmer says. The machines are now in place but somehow the customers are not being reached. Consequently, the client volume per ATM is declining.

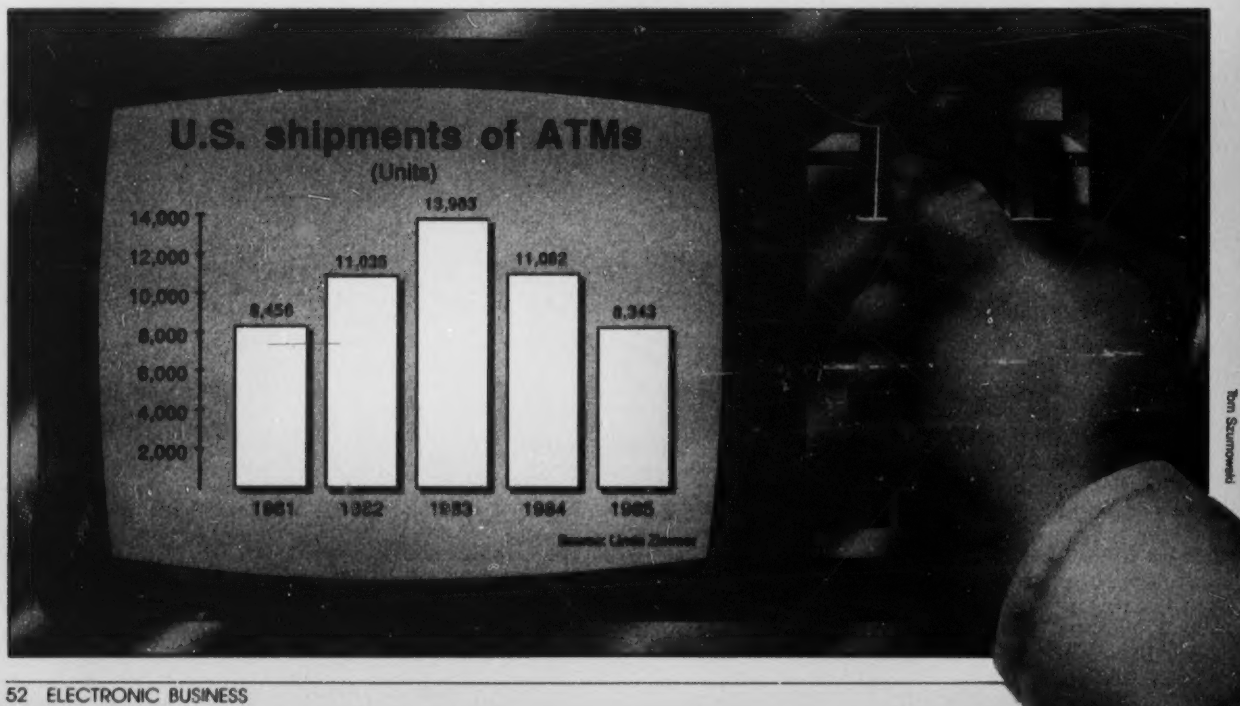
Two years ago, on the other hand, the average machine sported about 6,700 transactions per month. That number now stands at about 5,500 monthly transactions per machine. And no one is quite sure how to increase the ATM customer base.

Virgil Freeman, vice president and general manager of the electronic funds transfer (EFT) division at Olivetti U.S.A. in Dallas believes another problem may be that banks just have not had time to pay attention to the future of electronic banking. In recent years, merger and acquisition activity has dominated the banking industry, Freeman notes, and this has drawn attention away from investments in technology. Those banks that want to do the acquiring really need to keep their assets as liquid as possible and are delaying any major capital expenditures until their acquisition programs have been sorted out, he says. With uncertainty about the way bank mergers and acquisitions are shaping up, a lot of potential bank customers are holding off making any decisions related to electronic banking until they know whether they will be acquired or be a survivor.

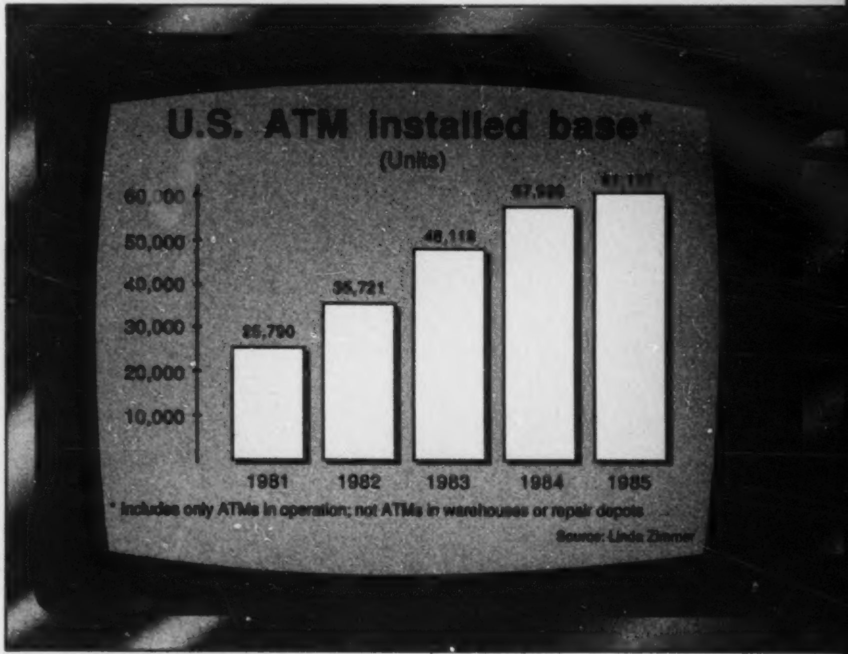
Economic considerations

Another element of the same picture is that the economy in some parts of the country has not been all that rosy. The economic recovery has been fairly regional and banks located in some of the more depressed areas, such as the Southwest and Midwest, have seen some pressure on their earnings. Again, in an effort to prop up that balance sheet, a number of banks are trying to keep a tight fist on expenditures. ATMs have been put on the back burner.

Kevin Murphy, senior vice president of marketing for Fujitsu America, Inc., does not see anything in the near future that will take the ATM manufacturers above the 8,000 to 10,000 shipment level. Fujitsu, which entered the ATM market in the United States about 1984, has tried to find its



Tom Szumowski



market niche by concentrating on building off-premises banking machines, especially the type that will be installed in retail outlets such as grocery stores, variety stores and convenience food stores.

While Fujitsu goes after the off-premises market, other experts believe the ATM market will be helped in the future by the need for replacement equipment. "The financial industry is finding that the installed base [of ATMs] is aging and is getting troublesome," Olivetti's Freeman says. In fact, Zimmer estimates that about 25% of the shipments in 1985 were for replacement machines. Other industry experts expect that a sizable portion of future demand for the machines will come about as existing ATMs start to wear out.

One bright spot for future ATM purchasers is that the average cost of an ATM is one-half to two-thirds of what it was two years ago. Additionally, the average maintenance cost has been cut by 50% to 60%. Some of that has to do with the new technology for ATMs — which is making the machines more reliable and easier to service, Freeman says. Also, manufacturers are offering financial institutions very attractive financing plans and leasing plans for the equipment.

But another reason for the lower cost is that the ATM manufacturers are very competitive and some of the vendors have decided to compete by cutting prices.

About the time when shipments of installed ATMs declined dramatically and demand was nowhere near reaching the level of available product, the market became even more glutted as two Japanese manufacturers, Omron Tateisi Electronics Co. and Fujitsu entered the competitive fray. In 1984 NCR Corp. was still a relative small player with about 8% of the market and the market leaders were clearly Diebold Inc., IBM and Olivetti.

But the rankings have changed. The two Japanese companies made some small inroads in the ATM market in the United States, but perhaps more noticeable is that NCR is said to have made a significant and definitive increase in its market share through price cutting. As one competitor, who asked not to be identified, puts it, "NCR has done a very good job of getting serious about ATMs and closing sales."

While market share numbers for this business are a bit elusive, manufacturing sources line up the U.S. contestants like this: Diebold 40% (down from 50% two years ago), IBM 15% (down from 20%), NCR 15% (up from 8%), Olivetti 15% (down from 20%) and the remainder is split between Omron, Fujitsu and other smaller manufacturers.

Promoting use

Some industry observers also believe the market is suffering from a lack of adequate publicity. While some banks have undertaken such ATM promotions as vacation giveaways, other banks — in fact the majority — have done little or nothing to encourage customers to use the machines. Manufacturers agree that until this problem is taken care of, it is unlikely the customer base will increase dramatically. They also believe it is up to the banks to get customers to use electronic banking.

But some banks do not want to undertake advertising campaigns because they are concerned that it will benefit their competitors who are also hooked onto the same network. Other banks are getting around that by charging customers for using another bank's ATM within the same network.

During this lull in activity some banks may be taking the opportunity to actually plan what they want in the way of ATM systems down the road. Perhaps some banks may want to focus just on promoting the use of cash dispensers, since about 80% of all transactions are cash withdrawals. Not only are cash dispensers cheaper to buy, but it requires considerably fewer transactions in order to reach the break-even level.

Or perhaps some banks want to develop a complementary family of terminals. In a high-volume location, perhaps it would make sense to have a full-service ATM adjacent to a cash dispenser. In a low-service area perhaps just one type of machine would suffice. In other locations, a bank may find it makes sense to have interactive terminals that would display information on interest rates, investment opportunities or the different banking services that are available.

The future of EFT may also include other things, however, says Robert Jansen, president of Omron Financial Systems of Los Colinas, Texas, a subsidiary of Omron Tateisi Electronics Co. "EFT could also be the ability to handle the dispensing and taking in of commodities other than cash," says Jansen. "This might be a ticket to an event or a money order, for instance." And these prospects could open up new opportunities for financial institutions as well.

But until the banking industry works out some of its own problems, analyst Zimmer does not see much change in the near future for ATMs. And for the next 18 months her outlook is for a pretty flat market.

LISABETH WEINER

Weiner is a Chicago-based business writer

Strategic shift: Japan searches for new formula

Low-cost production and consumer products are no longer Japanese monopolies. Exports have begun to suffer

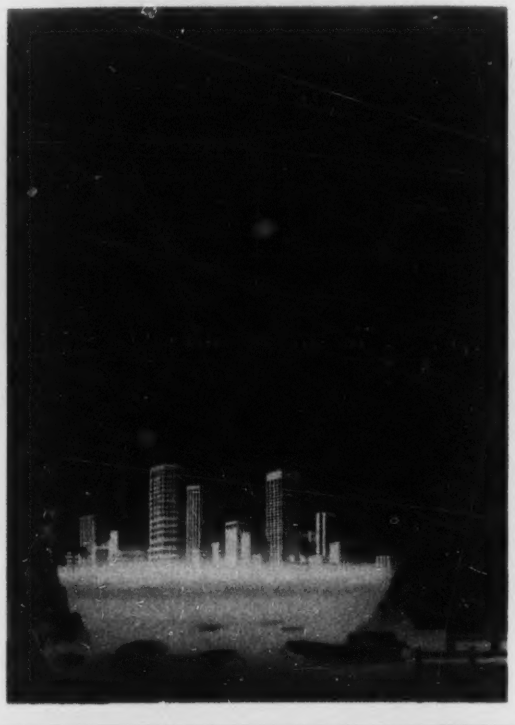
By Norm Alster

Several months ago, when the yen-dollar ratio first dipped below 160:1, Akio Tanii, president of Matsushita Electric Industrial Company Ltd. characterized the currency situation as "extremely severe." Although Matsushita was said to be making "a great effort to cope with the situation," the adverse impact of a 160:1 ratio, according to Tanii, "far exceeds the corporate limit of our efforts." Tanii's proposed solution to the problem was intriguing. He called on the Japanese government and the Bank of Japan to immediately implement a powerful program to expand domestic (Japanese) consumption.

Like so many pronouncements recently emanating from Tokyo, Tanii's words carry a strange ring. The Japanese, known for years for their export orientation, for their mastery of commodity manufacturing and for their high personal-savings rates, are now talking more and more about importing commodities and raw materials, establishing their own manufacturing overseas, counting less on export growth, concentrating on the higher value-added end of markets and stimulating domestic consumption at the expense of savings.

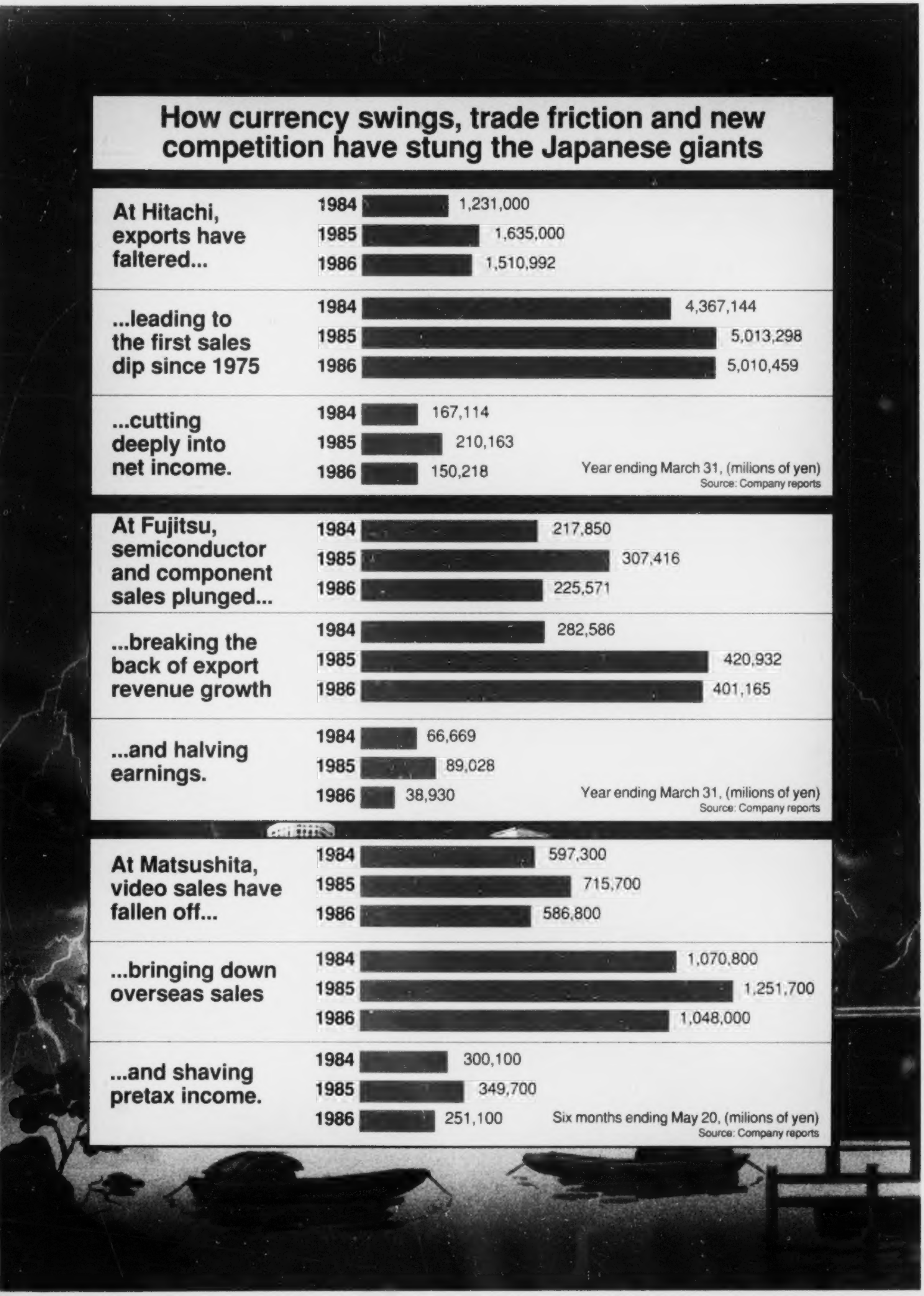
Already, there are two schools of thought on what Japan's new direction means for its American and European competitors. Some observers believe that, with the Japanese deviating from what has been a remarkably successful economic strategy, its rivals stand at a point of rare and unprecedented opportunity. But others argue that Japan is not really reversing course but simply accelerating on a course long planned and carefully mapped. That course will bring the Japanese into direct competition with American rivals in the markets and technologies that have so far served as their sanctuary. As such, current conditions may actually represent a moment of maximum peril for Japan's industrial competitors.

But to understand why current conditions offer both danger and opportunity for Japan's rivals, it is important to understand why the Japanese appear to have embarked on an industrial program that deviates so sharply from the successful policies of the last four decades. Essentially, the Japanese now have little choice but to change. A powerful combination of influences — some foreseen and some unforeseen — have undermined their traditional policies and have already begun to damage their financial performance.


David Biedrzycki

During the first quarter of 1986, Japanese gross national product (GNP) declined for the first time in eleven years on a quarter-to-quarter basis. Since Japanese yearly growth rates have averaged double those of the U.S. since the 1960s, ranging roughly between 4% and 12%, an actual decline in GNP represents an abrupt reversal of form. Most ominously, the GNP drop of 0.5% actually concealed a more dramatic 4.9% drop in exports, the lifeblood of Japan's economy for more than two decades. Consumer giant Matsushita, for example, saw its exports drop by 17% in the first six months of 1986, the major factor in an earnings decline of 14%. With export sales down 8%, Hitachi Ltd. experienced its first decline in earnings (off 29%) in eleven years. Fujitsu Ltd.'s net income was off by 56% in the fiscal year ending March 31, 1986. NEC Corp.'s earnings fell by 59% in the same period. No wonder then that the Economic Planning Agency recently pronounced the Japanese economy to have entered recession.

"There are a lot of Japanese companies that are hurting very badly right now," reports Sidney Webb, a member of the board of directors of both Amdahl Corp. and Avnet Corp. and a consultant to several major Japanese electronics firms. Although the



How currency swings, trade friction and new competition have stung the Japanese giants

MATSUSHITA's TANII called on the Japanese government and the Bank of Japan to expand domestic consumption

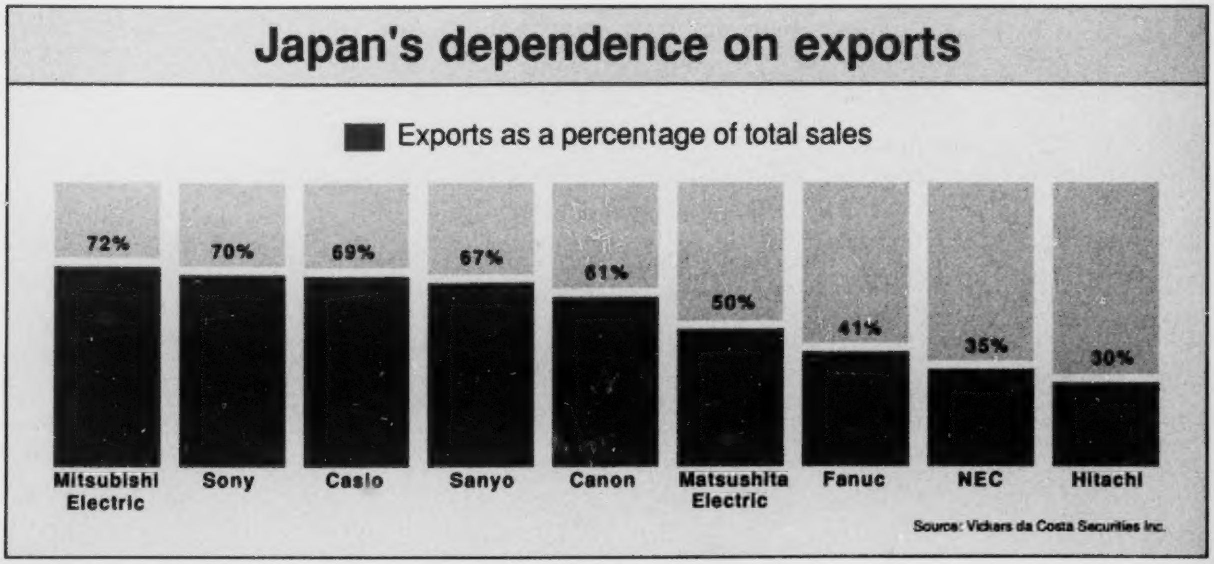
Japanese problems run deeper than the 50% appreciation of the yen versus the dollar, there is no denying the painful consequences of currency reversal for Japan's export-driven manufacturers. "When you are focusing on exports like the Japanese, currency fluctuations may be one of the most important variables in your business and may be more important than everything you do," explains Webb.

The appreciation of the yen is disruptive because it puts upward pressure on the price of Japan's exports. Japan's economic growth is unusually dependent on exports since its protected domestic markets are already controlled by its own firms. There are, in essence, few foreign-based companies (IBM being the most notable exception) from which market share can be wrested. Thus revenue can be grown in only two ways: by significantly expanding the size of the domestic market or (more typically) by selling abroad. In semiconductors, for example, Japanese producers control roughly 90% of their domestic market. With almost no market share left to win (and with foreign rivals clamoring to increase their own shares), growth for the Japanese must come from significant expansion of domestic demand or from penetration of foreign markets. To this date, of course, the Japanese have been remarkably successful in growing through export sales. In 1964, says Stephen Levy, chairman of the American Electronics Association and chief executive of Bolt Beranek and Newman Inc., Japanese exports of high-technology goods were already 1.5 times as large as their imports. But by 1985, while the U.S. trade deficit in electronics approached $9 billion, Japanese high-tech exports were fully five times as great as their imports.

But now, at the very time that an enormous export advantage (the strength of the dollar) has turned into an equally enormous disadvantage (the strength of the yen) Japan's export-based economic master plan has been challenged on two other fronts. Discontent with Japanese business practices, commonplace but ineffectual for years, has suddenly crystallized into lawsuits, legislation and remedial duties. Meanwhile, new competition from Korea and other Far East countries has challenged Japan's domination in some of its most crucial export markets. While Japanese exports were declining, Korea's exports rose by 24% and Taiwan's by nearly 20%.

Considerable attention has been focused on the semiconductor market, in which Japanese sales in the United States were down close to 22% in the first five months of this year. Although it is still too early to make a definitive assessment, it is likely that the new semiconductor trade agreement, which imposes much higher selling prices on Japanese chips, will (in markets where the Japanese do not hold virtual monopolies) have at least some negative impact. In semiconductors, therefore, it is the combination of currency and trade friction that is hurting Japan. But in a much larger export market — consumer electronics — it is the combination of currency and foreign competition that is taking its toll. "Ten years ago we were producing the black and white television sets. But right now almost all the black and white sets are made in Korea and Taiwan. And some of the color [sets], too," reports Ikuo Makino, director of industrial electronics

> Japan's economic growth is unusually dependent on exports since its protected domestic markets are already controlled by its own firms



Source: Vickers da Costa Securities Inc.

for the Japan External Trade Organization.

Sanyo Electric Co. and Victor Company of Japan (JVC) now put their labels on color television sets produced by Korean manufacturers. More dramatic is the situation in video cassette recorders. Until recently, the Japanese held a virtual monopoly on video-cassette recorder (VCR) manufacturing. Products sold under American names such as Sears and General Electric are actually produced in Japan. But in 1985, the Koreans managed to sell more than one million VCRs in the United States. And now the Japanese have actually begun to put their labels on VCRs built in Korea. David Rosen, director of the consumer electronics media program for Link Resources Corp., a New York City-based market research firm, says that Sony Corp. and Toshiba Corp. now sell VCRs manufactured by the Daewoo group. And JVC has begun to source some of its products from the Samsung group and the Lucky-Goldstar group. "The Koreans can underprice the Japanese in terms of manufacturing costs," says Rosen.

Beneath the surface

The ability of the Koreans, Taiwanese and others to undercut Japanese pricing on a broadening base of consumer products and computer subassemblies suggests that the Japanese may be losing their most critical competitive advantage: the ability to manufacture high-volume products at lowest cost. The Japanese have always been able to capitalize on low-cost manufacturing to dominate commodity products. But now it appears that low-cost manufacturing itself is evolving into a commodity [ELECTRONIC BUSINESS August 15, 1986 p48].

> The Japanese may be losing their most critical competitive advantage

In one sense, it was the extraordinary level of Japanese manufacturing proficiency that catalyzed this process. Ever since it became evident that the Japanese had advantages in high-volume manufacturing, electronics companies competing with the Japanese have sought to neutralize that advantage. One way was to build plants in countries with even lower labor costs. Today, the expanding electronics industries of Hong Kong, Korea, Singapore and Taiwan are the direct and major economic consequence of such investments by U.S. and European firms. In Korea, for example, semiconductor manufacturing and assembly industries have grown on a base constructed by firms like Fairchild Camera and Instruments (now Fairchild Semiconductor Corp.), Motorola Inc. and Signetics Corp. The presence of these companies attracted and developed the skilled laborforce, accomplished technical class and supplier network necessary to sustain a native industry.

EPSON's TSUBOTA: "We're seeing in Japan now what was happening in the U.S. 10 to 15 years ago. . . Manufacturing plants are moving offshore"

Howard Rosenberg

As lower labor-cost competitors have gained strength, the Japanese have tried to keep ahead of the game through automation. But the Japanese have begun to hit the wall of diminishing returns in their own cost-reduction efforts. Jerry Wasserman, a vice president with Arthur D. Little Inc. in Cambridge, Mass., points out that many Japanese electronics firms are already fully automated. With little room for improvement, Japanese operations will continue to lose ground relative to their competition. Japan's Far East competitors, not content to sit on their labor-cost advantages, have been surprisingly aggressive in their efforts to improve quality through automation. "Everybody else is becoming automated. They're no longer unique," concludes Wasserman. "The delta between Japan and the rest of the world is becoming smaller." Although Japan's wage rates have been steadily creeping up on U.S. wage rates, the 160:1 yen-dollar equation actually makes Japanese labor slightly more expensive than U.S. labor, according to the Industrial Bank of Japan.

The Japanese have been working hard to offset the erosion of their manufacturing advantages by wringing further costs out of production. But Andrew Wei, division general manager with the Graphics Devices and Systems division of Seiko Instruments and Electronics Ltd., believes that the potential for significant gains in what are already efficient manufacturing operations is shrinking. "With the cost structure," says Wei, "there's only so much you can do."

The most compelling evidence for the dilution of Japan's manufacturing superiority comes from the pragmatic business practices of the Japanese themselves. Just as the Asian upstarts have duplicated the Japanese economic master plan, Japan's actions now eerily parallel those of U.S. manufacturers. "We're seeing in Japan now what was happening in the U.S. 10 to 15 years ago," explains Yasuhiro Tsubota, president of Epson America. "Japanese companies are producing in Korea and Taiwan more than in the past. Manufacturing plants are moving offshore." The Japanese are also buying more from their Asian rivals. Hitachi's procurement of materials offshore increased by 16% (to $868 million) in the fiscal year ending March 31. Overall, Japanese imports from Hong Kong, Korea, Singapore and Taiwan were up by roughly 20% in the early months of 1986. Imports of manufactured goods from Korea actually rose by more than 33% in the first quarter of 1986 (as compared to the first quarter of 1985).

> The Japanese have begun to hit the wall of diminishing returns in their own cost-reduction efforts

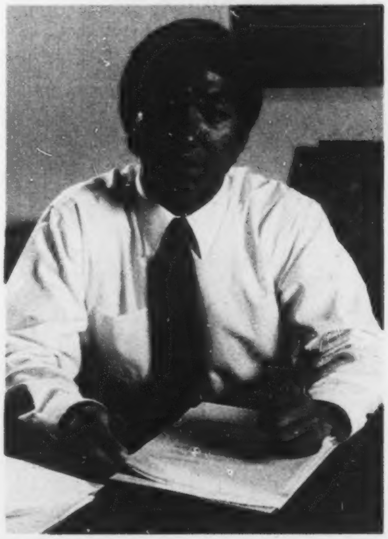
The Japanese counterattack

With their business tactics under fire, their pricing advantage evaporating and their most strategic competitive advantage in dilution, the Japanese have not been twiddling their thumbs. Their efforts at moving some of their own production offshore and their sourcing of some finished goods and raw materials (one advantage of the yen's strength is the falling price of imports into Japan) are part of their more immediate response. They have also accelerated their investments in U.S. manufacturing, hoping to damp American resentment and bypass foreign import duties. Matsushita, for example, now has U.S. production facilities for color televisions, car audio systems and VCRs. The Japanese, moreover, now have a 50%, or more, stake in 405 U.S. manufacturing and assembly companies, according to the Japan Economic Institute. External component sourcing, foreign production and stringent cost reduction programs are all intended to help the Japanese hold the line on pricing to retain export market share. But Japan does not appear to be betting its future on restoring its competitive advantages of the past.

Actually, the Japanese have something quite different in mind. Japanese executives, when pressed on the subject of Far East competition, rarely stress their ability to regain control of commodity markets. What they emphasize is their ability to compete at the "high-end," the "value-added" sector, the "leading edge." It is interesting, for example, to hear Sho Nakanoma, president of NEC Electronics Inc., discuss the threat of Koreans in semiconductors. "I think it's possible the Koreans could become the dominant world supplier of commodity memories," Nakanoma concedes. "But the market needs more sophisticated products rather than commodity products." For U.S. semiconductor leaders who abandoned commodity memories to concentrate on the most technologically sophisticated devices, those must be chilling words.

The Japanese thrust toward technology leadership should come as no surprise. Even as many observers have continued to question their ability to innovate, the Japanese have been investing the booty of their export conquests in technology development.

From 1978 to 1983, the top 20 Japanese corporations increased their research and development budgets at a more than 20% annual rate, according to George Stalk Jr., a vice president and director of the Boston Consulting Group, who has studied Japanese industry. Japan's acceleration of R&D spending is even more impressive when that country's low inflation rate is factored in. Adjusted for inflation, Japan's R&D spending still grew at more than 17% a year in real terms: a doubling of expenditures over that period. As a percentage of gross national product, Japan's civilian R&D has almost doubled since 1960, now standing at roughly 2.5%. Total U.S. R&D spending, meanwhile, has inched along and now stands at roughly 1.6%.



SEIKO's WEI sees Japanese consumer electronics giants moving into industrial and business markets

Lianne Enkelis

The returns on Japan's investment in R&D are now becoming apparent. Last year both Hitachi and Toshiba surpassed IBM in the number of U.S. patent awards. Of all U.S. firms, only General Electric (778 patents) managed to stay ahead of Hitachi (693) and Toshiba (662) in new awards. Canon and Fuji Photo Films also earned enough patents to give Japan four of the top 10 U.S. patent grantees.

At the very moment that American electronics manufacturers face an unprecedented opportunity, they also stand at the point of maximum danger

Bereft of low-cost manufacturing preeminence, Japanese manufacturers understand that they now must become leaders in value-added quality products and in services based on information technologies. "The pressures on the Japanese companies are more intense than ever to push in the direction of taking the technological lead because the alternative for them is to try to sell cheap with an expensive yen. And that isn't viable," explains Stalk.

The shift may well mean more than the emphasis of an NEC, let's say, on nibble mode or video random access memories as opposed to simply standard 256k × 1 commodity items. Potentially more threatening is the shift in focus of Japanese consumer electronics powerhouses that, until now, generally have steered clear of semiconductors, computers, production equipment and office machines.

In 1985, Japanese consumer electronics production, once a steady double-digit gainer, grew just 4%. Consumer elctronics, moreover, is the ultimate export industry, with roughly 70% of output sold abroad. With such heavy currency exposure and with new low-cost competition making rapid gains, Matsushita, Seiko and Sony Corp. and other wizards of consumer gadgetry are understandably eyeing new, more specialized markets. "It's very possible that we may actually be witnessing the early stages of a reorientation of some of the Japanese consumer electronics industry companies into more industrial-type and business-type applications of technology," observes Seiko's Wei.

Wei explains that for Japanese makers of consumer products besieged by lower cost competitors, simply increasing technology content may not be enough. As the home computer industry will attest, technology is no guarantee of broad-based consumer appeal. With Japanese consumer powerhouses beginning to eye the office and industrial markets long dominated by U.S. equipment manufacturers, even companies relatively free, until now, of foreign competition may begin to hear footsteps.

For U.S. firms, the implications of such radical shifts in Japanese planning are enormous. Because at the very moment that American electronics manufacturers face an unprecedented opportunity, they also stand at the point of maximum danger. The Japanese realize that they can no longer support their operations through unchallenged monopoly positions in commodity markets. Their mighty manufacturing apparatus, nonetheless, must be kept busy. The Japanese must move up. They have been planning for it all along. And it is American firms that stand in their way. ☐

NEWS ANALYSIS

Opportunity knocks: A chance for U.S. high tech

The same aggressive financial policies that underlie Japan's success can now aid many U.S. companies

By Norm Alster

The problem for Japanese exporters comes down to this: How can they respond to current business conditions without sacrificing profitability, market share or investment? The appreciation of the yen puts upward pressure on the prices of Japanese exports at the very moment that the Japanese face furious competition from low-priced Asian competitors. If the Japanese do not cut prices, they will lose business and market share. If they do cut prices, their traditionally thin profit margins will be under extraordinary pressure. In either event, whether they choose to sacrifice sales or margins, the Japanese face pressure to cut back on their budgets; particularly capital spending, and research and development.

The problem for U.S. electronics firms comes down to this: With their Japanese rivals both compelled and determined to confront them head-to-head in technology leadership, how can American firms best exploit Japan's current problems?

Surely, there is no single answer for all companies in the U.S. electronics industry. Firms of differing sizes and strengths in diverse industry sectors face different levels of Japanese competition in markets with varying growth rates and pricing environments. However, many U.S. firms facing Japanese competition are now in excellent positions to avail themselves of one of the prime competitive tools of their Far East rivals.

It is remarkable, really, that with so much attention devoted to documenting and emulating everything Japanese, little attention has been focused on the fundamental financial practices of Japanese corporations. And yet there is reason to believe that the same aggressive financial policies that underlie Japanese industrial success could now enable many American firms to turn back their foes. U.S. firms hoping to take advantage of current conditions would do well to consider some combination of the following practices:

- Aggressive pricing to regain or win new market share
- Accelerated and, in some instances, unprecedented spending on research and development and capital improvements to secure long-term cost and technological advantages
- Rapid accumulation of cash to support such efforts through more aggressive borrowing and/or dividend cuts.

This has been the Japanese program. Now, with the Japanese facing a unique array of serious threats, many of these companies are stretching thin and will, increasingly, be forced to cut back on the aggressive investment and pricing policies they favor. U.S. firms able and willing to sacrifice some near-term profitability for market share expansion at the expense of hamstrung Japanese challengers can benefit most from more aggressive financial policies.

"What people underestimate is the effect of aggressive financial policies on the ability to sustain growth or even produce growth that's faster than your competitors'," argues George Stalk Jr., a vice president and director of the Boston Consulting Group and co-author of *Kaisha*, a study of the Japanese corporation. "All else being equal the levered company is going to be able to grow faster than the unlevered company. And the consequence of that is that the levered company is going to be able to drive down its production costs faster. . . . The levered company which started out in the poor profitability position ends up, because of its growth and its improved competitive position, as the more profitable company."

"With a higher degree of leverage financing and a higher rate of growth, a company is able to ride down the experience curve faster and thereby drop prices," agrees Steven Schlossstein, manager of Japanese institutional sales for Vickers da Costa, an

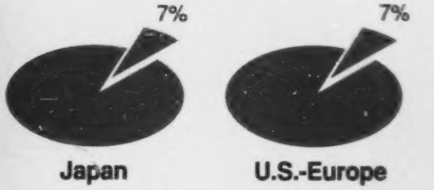
David Biedrzycki

Why Japanese companies can grow almost twice as fast as U.S. and European companies

Japanese electronics firms have demonstrated the ability to grow faster than most of their U.S. and European rivals. To understand why, the Asian Advisory Service, a Tokyo-based consultanting group, studied the financial structures and performance of two groups of electronics companies in the 1983-1984 time period. The following chart explain why the Japanese companies have an average sustainable growth rate (the ability to grow assets without changing capital structure or dividend payout) roughly twice that of the U.S.-Europe group.

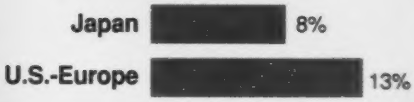
1. It is not because the earnings of Japanese companies are higher

Pretax, pre-interest earnings as a percentage of sales



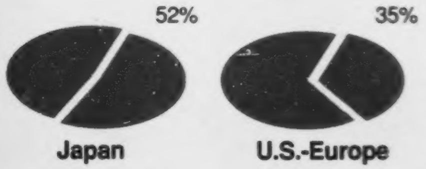
2. Although Japanese companies can borrow money at lower rates...

Average interest rates on debt



3. ...this advantage is offset by higher tax burdens

Taxes as a percentage of pretax income



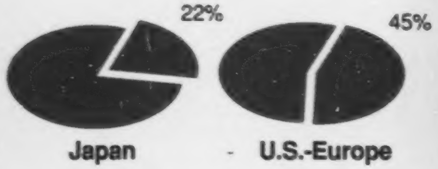
Study groups:

Japanese companies: Fujitsu Ltd., Hitachi Ltd., Matsushita Electric Industrial Co. and Toshiba Corp.

U.S. and European companies: General Electric Co., IBM, N.V. Philips GL and RCA Corp.

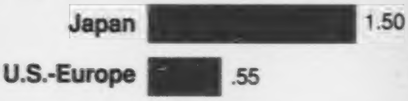
4. The reason is that U.S. and European companies pay out more in dividends

Dividends paid out to shareholders as a percentage of net income



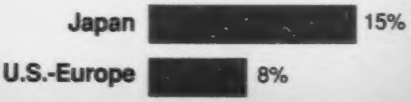
5. The money saved in dividend payouts is then combined with much higher levels of borrowed cash

Long- and short-term debt to equity ratio



6. The money is used to subsidize the pricing advantages and high levels of capital investment that afford higher sustainable growth rates

Rate at which companies can expand assets without altering debt equity or dividend payout ratios



investment banking firm, and the author of *Trade War*, an analysis of U.S. and Japanese economic policies.

The use of more aggressive financial policies is sure to be a controversial issue. Companies struggling to break even will be understandably reluctant to take on new fixed costs. But aggressive financial policies should not be seen as the defensive last resort of the financially weak firm. More likely, beneficiaries of such tactics are companies with strong balance sheets that would like to grow at the expense of a larger competitor, or those that need to stave off a smaller but more financially aggressive rival.

It is understandable that U.S. electronics industry leaders, many of which achieved significant market share and size without significant Japanese challengers, have kept their debt low. But debt formulas that are appropriate in tame competitive environments can become a burdensome disadvantage for firms targeted by the Japanese. Financial conservatism makes a large firm an easy target for the financially aggressive challenger, according to Stalk. Japanese companies have typically used leveraging to grow at the expense of larger, more established U.S. competitors. The average debt to equity ratios for U.S. manufacturers, says Stalk, is 0.6:1. The average Japanese manufacturer maintains a 1.6:1 debt to equity ratio. U.S. semiconductor companies, for example, maintain debt to equity ratios that only rarely approach 0.5:1. But NEC Corp., which recently overtook Motorola and Texas Instruments as the leading worldwide merchant supplier, has been fueled by high-power debt to equity ratios as rich, in recent years, as 4:1.

Japanese companies have traditionally taken on high levels of debt to finance market share expansion in high-growth markets. "The name of the game is cash: cash I can earn for myself and cash I can borrow and what I can do with the combination," says Stalk. By borrowing more, Japanese companies can increase R&D expenditures more rapidly and add plant capacity more rapidly. With greater production capacity, they can focus on wresting market share. Success in this, in turn, drives down pro-

Could your firm benefit from leveraging?

Increased debt is not for everyone. Companies with strong balance sheets can more easily expand debt without significant credit rating changes and without offering concessions or losing management control to bankers. Firms with pedestrian technology, undistinguished product and weak marketing plans will not be miraculously transformed into unstoppable engines of growth.

How can you tell if your company would benefit from more aggressive financial policies? George Stalk Jr., a vice president and director of the Boston Consulting Group and an advocate of aggressive financial policies, says executives can begin by asking themselves the following questions:

"Are you facing a competitor that is substantially bigger or smaller than you are? If so, do you have very different financial ratios; by that, I mean dividend ratios, leverage ratios, interest rates and taxes?"

If your competitor is smaller than you but is growing faster and has more aggressive financial policies or, alternatively, if your competitor is much larger than you and has very conservative financial policies, then it may be time to reconsider your own financial assumptions.

If, says Stalk, you are a small firm competing against a large conservative firm you are in the classic situation to benefit from leveraging. Like the Japanese firms that targeted the giant American and European market leaders, you can use debt to finance pricing advantages. If, moreover, you are in a growth market, you can leverage to expand at a rate equal or better than the overall market.

Large diversified companies facing smaller, more aggressive, growth-minded challengers can also benefit from more aggressive financial policies. The larger company will not generally face a small aggressive competitor across all of its product lines. Most likely, the smaller company is growing at the expense of a division or product line within the large firm. The problems of divisions within large companies can often be traced, Stalk contends, to corporate formulas such as "hurdle rates." Essentially, a hurdle rate requires a proposed investment to exceed a certain rate of return. If, therefore, a division cannot justify a new plant or sales office by exceeding this corporate-wide requirement, then it is not likely to get the funds. The problem, says Stalk, is that hurdle rates are uniform and, as such, ignore the realities of competition: the hurdle rate, for example, might be the same whether "they're in janitorial services or making microprocessors." But that microprocessor division may have a well-financed, start-up competitor willing to invest for market share growth with a lower guaranteed rate of return. "The poor guy in the division within the diversified company has to clear a hurdle rate that is too high to compete with someone that has a lower hurdle rate."

Faster growth markets readily reward increased investment since they can better absorb added capacity

Company-wide financial guidelines may make sense to accountants but they mean trouble for large companies with divisions in competitive international industries. "The single greatest handicap American managemnt has is that they average everything," Stalk concludes. Instead of investing by formula, he argues, they should be investing in response to competitive circumstances.

Aggressive financial policies can work in both high and low growth markets. But, says Stalk: "The power of the policies to affect relative competitive position becomes much more pronounced in faster growth markets. Faster growth markets mean that you need more cash relative to the assets you have." Such markets readily reward increased investment since they can better absorb added capacity. Slower growth markets may require price cutting (which can be funded by added debt) to expand market share. ☐

duction costs. Meanwhile, with the enhanced cash flow from borrowings, they can subsidize price cuts.

The financially aggressive firm has market share as its objective. It uses borrowed cash, not profits, to grow. And what it earns, it plows back into investment, paying very low dividends. Schlossstein of Vickers da Costa, summarizes the different financial outlooks of U.S. and Japanese companies. "American companies will sacrifice growth to preserve high profits. Japanese companies will sacrifice short-term profits in order to capitalize on growth."

A recent study by James C. Abegglen, co-author of *Kaisha* and president of the Asia Advisory Service, a Tokyo-based consultancy, analyzed the impact of differing financial policies on the long-term growth capabilities of two groups of major electronics manufacturers. One group consisted of seven U.S. and European firms: General Electric Co., IBM, N.V. Philips' GL, RCA Corp., Siemens AG, Texas Instruments Inc. and Westinghouse Electric Corp. The Japanese group consisted of Fujitsu Ltd., Hitachi Ltd., Matsushita Elecric Industrial Company Ltd., Mitsubishi Electric Corp., NEC Corp., Sony Corp. and Toshiba Corp.

Abegglen found that the Japanese companies had sustainable growth rates (defined as the rate at which a company can grow assets without changing its debt, equity or dividend payout ratios) almost twice as high as the U.S.-Europe group: 15% as compared to 8%. Abegglen analyzed the reasons for the superior Japanese growth capability. He found, interestingly, that the groups performed with equal efficiency in pre-interest, pretax, predividend earnings as a percentage of sales: in the 1983-1984 period on which the study is based, each earned 7% of sales before allowance for interest payments, taxes and dividends.

The Japanese, of course, were carrying far heavier debt: on average, 1.5 total debt to equity as compared to .55 for the U.S.-Europe group. The conventional explanation would be that the Japanese can carry more debt because they can borrow at lower interest rates. This advantage in lower capital costs, therefore, would allow them to borrow more and grow faster without incurring high yearly interest payments.

Some of this is true. The Japanese did have lower costs of capital: an average effective interest rate of 8% versus 13% for their Western competitors. However, these lower costs were offset by their much higher tax rates. While the Western firms paid out an average of 35% of pretax income, the Japanese companies paid out 52%. Higher taxes and lower interest rates balanced out. What then accounted for the difference in growth capabilities? Part of the answer lies in the higher levels of cash available (from borrowings) to the Japanese for investment and for price-cut subsidization. The other major factor is dividend payout. Japanese firms paid just 22% of their profits in dividends but the U.S.-Europe group paid out 45%.

SIDNEY WEBB: "Bucking the financial community doesn't help a CEO's career or his stock options"

> "I think most companies are afraid to get too leveraged for fear they will be criticized on Wall Street"
>
> Sidney Webb

These figures belie the common impression that U.S. electronics firms pay low dividends. In some cases, of course, this is true. But in many other cases low dividend yield is confused with low payout. IBM, for example, pays a $4.40 dividend. This does not sound like much on a share price of, let's say, 135. The dividend yield of 3.25% is meager compared to the 10% and higher dividend yields of many utility and energy stocks. But IBM has 618 million outstanding shares. So IBM is actually paying out a king's ransom of $2.7 billion; roughly 41% of its $6.5 billion of 1985 net earnings. RCA paid out 60% of its earnings during the two-year period from 1983 to 1984. Fujitsu, Hitachi and Matsushita, meanwhile, were paying out less than 15% of their earnings in dividends.

It is the combination of retained and borrowed cash that allows companies to grow. The Japanese, by taking on debt and limiting dividend payouts, are therefore able to grow twice as fast as their competitors. While their lower cost of capital is a factor, according to Abegglen, it is offset by higher tax payments. The decisive factors are low dividend payments and higher debt levels. And the critical application for available cash is growth. "The Japanese companies are by and large more comfortable with high growth than their American counterparts," says Schlossstein, noting that the Japanese will generally opt for growth and market share over short-term profits.

Why the iron is hot

There are a number of reasons to believe that now is the time to derive maximum advantage from the financial strategy long employed by the Japanese. For one thing, with the U.S. prime rate below 8%, the Japanese advantage in lower capital costs has been substantially narrowed. It has been a decade since money was so cheap. The refinancing of existing debt — often incurred at rates of 10% to 16% — lowers the costs of debt servicing and in itself allows firms more flexibility in taking on new debt. The currency situation, moreover, has made Japanese exports more expensive. The Japanese continue to show the value that they place on market share. They are now taking hits in earnings to keep prices down and retain customers. Even so, Japanese firms are raising prices slowly (to date, by 10% to 15%, absorbing the rest of the 50% currency exchange penalty) and if the currency situation persists, they will be forced to go further or accept serious earnings consequences. Such pressures are already resulting in capital expenditure cutbacks. A recent survey by Japan's Economic Planning Agency forecasts a 4.6% drop in capital spending during the second half of this year, the largest cutback since 1980.

(Continued)

Jim Caccavo

U.S. firms acting decisively now have the opportunity to apply capital in a variety of timely ways. "You might decide that in a given market or area that this is hurting the Japanese enough that now is the time to put the capital investment in, or some marketing effort, or to expand production or even cut prices," counsels Sidney Webb, a member of the board of directors of both Amdahl Corp. and Avnet Corp. and a consultant to several major Japanese electronic firms. Or, as T. Michael Nevens, a principal with McKinsey and Co. in Los Angeles, points out, a firm having to make a difficult choice between two competing research technologies could choose to hedge its bets and fund both.

At a time when the Japanese are finding it economically worthwhile to manufacture in the United States, American firms could take a cue from their rivals and modernize their domestic facilities. Says Stalk: "Instead of taking a chunk of business and going offshore, you may have the opportunity to offset a high-cost position through more aggressive financial policies. . . . If you say: 'OK, instead of going offshore I'm going to fix my factories and make them productive. I'm going to lever up like mad. I'm going to accept lower returns, supposedly. But I know I'll be able to generate more cash. Therefore, I'll be able to keep growing my way out of this problem.' There you have an argument for not going offshore."

Companies without sufficient cash flow might be reluctant to further depress their revenue stream through price cuts. But companies taking on debt would be able to subsidize such cuts and perhaps win the volume business and make the investments in added capacity that will bring down costs with time. Owen Robbins, vice president of finance for Teradyne Inc., has kept his firm's debt very low and is certainly not a proponent of high leverage. But he does allow that in markets which are price sensitive, higher debt would be an effective and reasonable tool for supporting more aggressive pricing. Schlossstein says that seizing the pricing advantage from the Japanese represents an enormous opportunity for U.S. firms to regain market share.

The downside

Why then, if there are such obvious benefits to more aggressive financing, do U.S. companies plod along with such conservative policies? Gary Arnold, chief financial officer for National Semiconductor Corp., says that firms in the semiconductor industry are constrained by the expectations of lenders and investors. "The markets in the U.S. just won't permit us those kinds of leverage numbers. The banks won't support it. The equity markets won't support that kind of leverage." Arnold says that a U.S. semiconductor firm increasing its debt to equity ratio to 1.1:1 would start attracting some concern. On the other hand, he says: "It's not atypical to see a major Japanese company with a total debt to equity [ratio] of 2.5 or 2.8." Asked if the ability of a Japanese company to take on more debt represented a disadvantage to its U.S. competitors, Arnold replied: "Clearly, it's a competitive disadvantage and it has been. That's nothing new."

NATIONAL SEMICONDUCTOR's ARNOLD says that firms in the semiconductor industry are constrained by the expectations of lenders and investors

Lianne Enkelis

> The company that sacrifices its future for quarterly earnings gains will realize the benefits of high stock valuation for only so long

If, indeed, this is the case it may be time to more closely examine the reason why U.S. firms would leave themselves at such a competitive disadvantage. The arguments against the use of higher debt levels to fund growth can be summarized as follows: The investment community has certain formulas for evaluating companies. Heavy debt adds to risk which will deflate the premium put on a company's share price. Heavy debt might also lower a company's credit rating, forcing it to borrow at higher interest rates. Heavy debt further functions as a drag on earnings since companies must take on higher levels of fixed interest payments. This would also tend to deflate share price, which is generally tied to earnings performance. Finally, the argument goes, borrowing does not make sense for U.S. firms since they must borrow at higher interest rates that the Japanese.

It is worth noting that most of these arguments revolve not around the inherent value of leveraging, but on the response of the investment community. Indeed, the issue raised again and again is that of stock price. "I think most companies are afraid to get too leveraged for fear they will be criticized on Wall Street," says Sidney Webb. But, is the fear justified? Is the penalty for leverage as steep as the penalty for "prudent" inaction?

McKinsey's Nevens explains that according to classical market theory a leveraged company would have more volatile earnings performance and, as a consequence, more volatile share price fluctuations. But Nevens has recently undertaken an investigation of that assumption. His preliminary observations suggest that some industries carry higher debt on average than the electronics industry without paying any penalty of share price volatility. If this is the case — and Nevens has not yet reached a definitive conclusion — then it would mean that some electronics companies would indeed have room to increase debt without incurring a market penalty.

But really, the whole notion of operating a company with an eye to how the stock market might react is just a cut or two above the employment of astrologers as management consultants. For one thing, the market tends to move in broad sweeps. In serious downturns, 90% of all stocks go down. Imagine keeping the lid on needed capital improvements and R&D to bolster share price only to have the market enter a steep downturn. Not only does your company's stock fall with the rest (perhaps not quite so steeply) but when the market turns around your competitive position has been eroded, most likely by rivals who made the tough decisions you avoided.

The company that sacrifices its future for quarterly earnings gains will realize the benefits of high stock valuation for only so long. And sure, the stock of a company that halves its earnings forecast will take an immediate hit. But an efficient market will eventually recognize long-term value beyond near-term earnings shortfalls. Even if the stock shows relative weakness for months, once the well-conceived program begins to show benefits it will outperform its competitors, whose competitive strength by then will have begun to erode.

Two notable examples: DEC and IBM. Digital Equipment Corp. was a relatively weak performer on Wall Street in 1983 and 1984, as analysts focused on its poor financial performance. But DEC, which pays no dividends, was spending more than any of its rivals (excepting IBM) on capital expenditures and R&D during the early 1980s [ELECTRONIC BUSINESS, January 1, 1986 p40]. DEC's $2.5 billion R&D investment (1981-1985) began to bear fruit last year as the company managed to completely overhaul its product line. DEC's stock has doubled, rising close to 100 points before a two for one split.

IBM, a company with almost negligible debt, suddenly began to borrow heavily in 1979. Almost overnight, it increased its debt sixfold, raising its debt to asset ratio above 30% for the first time in 15 years. Although there was some institutional flight from the stock and IBM shares performed poorly in the early 80s, the company would make a lot of money for anyone who bought it in 1982. That is because IBM was spending in early recognition of a manufacturing threat from Japan. The company's efforts to solidify its manufacturing base were expensive, but they were farsighted and the company's share price, once the advantages of that investment were recognized, has tripled since mid-1982.

Critics of leveraging will say that DEC and IBM are unique. IBM has unparalleled cash flow and market leadership. DEC has a unusually powerful chief executive (Kenneth Olsen) capable of leading the company where mere managers would fear to tread.

But really, DEC and IBM are perfect examples of the types of companies that can best make use of aggressive financial policies. Strong companies with strong balance sheets recognizing looming threats are more likely to benefit from such tactics than weak companies with weak technology and product. All too often debt is taken on only after the damage has been done. The firms that face rude awakenings are often those with the well-manicured balance sheets; the ones lullabied into sweet dreams by the reassuring rhythm of carefully orchestrated quarterly earnings gains.

Wasserman of Arthur D. Little suggests that the pressures for financial performance often overwhelm executives of American firms. "They are acting under the assumption that there are certain expectations within the financial community. If they don't perform, they'll be fired," he says. Webb, who has been both a board member and chief executive of major U.S. companies as well as a joint venture partner with the Japanese (TRW-Fujitsu), goes further in explaining executive's motivation. "Bucking the financial community doesn't help a CEO's career or his stock options," he observes wryly. The Japanese, it turns out, are free of such confusing pressures on decision making. "They don't have stock options for executives in the Japanese industries so they are not focusing on the short-term movement of the company's stock. I think that allows them perhaps to take a longer term view."

Because it is so difficult for an individual executive to convince Wall Street of the merits of aggressive financial policies, Webb suggests a cooperative industry-wide campaign: "My guess would be that the best thing U.S. industry could do would be to educate Wall Street and the investment bankers and try to get them to view the industry and stocks in a little different manner," says Webb. Chief financial officers could catalyze the process by re examining some of the sacred financial ratios.

But do American electronics firms really have the time to wait for such a movement to get started? The debates alone could last for years. Courageous and farsighted chief executives will simply have to move on their own. For the American company already lined up in the sights of a Matsushita, Seiko or Sony, as it targets business and industrial applications, time is mercilessly short. ☐

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ISDN: The network everybody is tuned to

Integrated services digital network is attracting a big audience — from chip suppliers to CO-switch vendors

By Carol Suby

In the quest to bring about a universal integrated services digital network (ISDN), component suppliers, equipment manufacturers and potential ISDN service providers are proceeding with caution.

The concept of ISDN — where the simultaneous transmission of voice, data and video over simple twisted-pair telephone wires — has been a ray of hope for a downcast communications industry. Most of its traditional segments have come under extreme profit pressure, so the prospect of a new business with new revenue opportunities has lifted the industry's spirits. Early ISDN entrants, however, will need deep pockets since significant financial returns are not expected until the end of this decade.

Since ISDN is a network and not a specific product, its value can only be measured by its impact on existing products or new components and equipment designed specifically for the network. The first year that vendors can expect to benefit financially from ISDN is 1988, says Dataquest Inc., when $455 million will be generated by the implementation of the network. In 1990, the San Jose, Calif., market research firm predicts that ISDN revenue will reach $2.6 billion — with $1.2 billion coming from equipment sales and the rest from transmission fees.

Manufacturers of customer premises equipment (CPE) will benefit most from the advent of ISDN, believes Victor Krueger, Dataquest's vice president of telecommunications industry services. In 1990, the network will add another $550 million to CPE vendors' coffers. By then, ISDN also is expected to boost sales of central office (CO) switches by $360 million and transmission/data communications equipment by $290 million.

ISDN suppliers and customers share Krueger's view that significant business opportunities will be created by the network. "The connecting chip between the user and the switch will be the winner," predicts Helmut Schwab, president of Siemens Components Inc. The "hottest selling product" will be digital telephones, says James Bendel, district manager of ISDN operations and terminal interface planning at Illinois Bell, one of the many telephone companies experimenting with ISDN service.

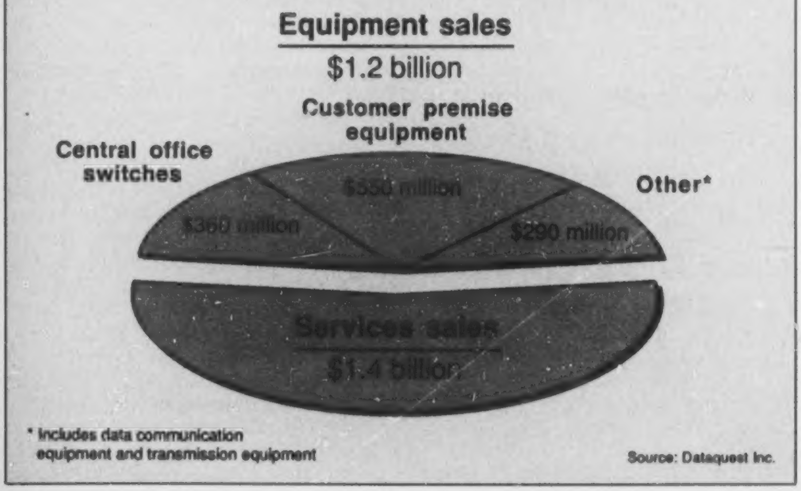
Smoke or fire?

Despite the reams of press articles, the deluge of seminars and the mass of ISDN product announcements, "there's a lot less action than the talk would lead you to [believe]," says Joseph G. Schatz of Arthur D. Little Inc., a Cambridge, Mass., management consulting firm. The industry-wide impression that ISDN is ready for take-off is quite different from the reality, according to an ADL study completed in mid-1986. Lack of standards is delaying some product development, end-users are still in the dark and the telephone companies are far from ready to offer complete ISDN services.

Nevertheless, "ISDN is a real and tangible market and [at the same time] a lot of smoke," in the words of Sean White, president of Northern Business Information Inc., a market research firm in New York City. "[Certain] services that will be provided by local telephone and long-distance companies are very real and

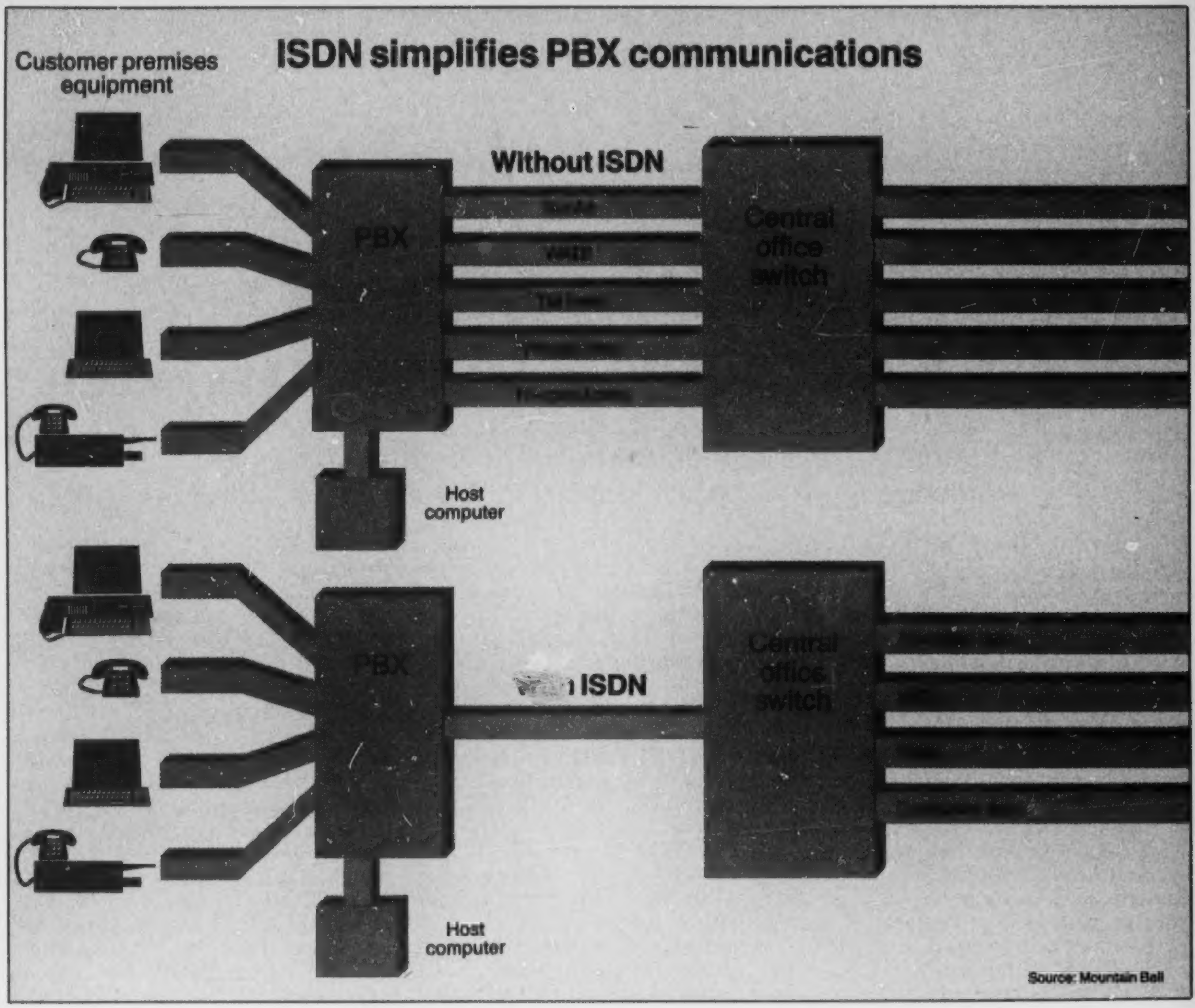
ISDN: A future industry

Projected 1990 integrated services digital network sales



* Includes data communication equipment and transmission equipment

Source: Dataquest Inc.


ISDN simplifies PBX communications

Source: Mountain Bell

are developing very quickly," says White. "But, if you're talking about everything ISDN was ever imagined to be, that's more marketing hype than reality."

The market researcher is referring to two services, known as 2B+D and 23B+D. Their names indicate the way that information is transmitted by each service. The basic rate, or 2B+D interface, is a facility provided by an ISDN network capable of transmissions over two B channels — carrying voice and data — at 64 kilobits per second (Kbps) and one D channel — carrying signalling information — at 16 Kbps for a total capacity of 144 Kbps. This type of service will generally be offered as a part of Centrex, which is a combination of services offered to businesses and generated by a CO switch.

The primary rate, or 23B+D interface, is a facility provided by the ISDN network capable of transmissions over 23 B channels and one D channel each at 64 Kbps for a total capacity of 1.544 megabits per second. This service will be provided by both local telephone companies as well as interexchange carriers such as AT&T, MCI and US Sprint and will generally go to large business users that have their own private branch exchanges (PBXs).

What exists from a hardware standpoint are a handful of chips, that are mostly in the development to sample stages; central office switches capable of some, but not all, ISDN functions; and CPE such as digital telephone sets, desktop terminals and PBXs that are close to being ready for ISDN trials scheduled for later this year and throughout next year.

> The industry-wide impression that ISDN is ready for take-off is quite different from the reality

Rather than a single ISDN chip that will bring the universal network to life, there will be numerous ISDN integrated circuits. Each will serve particular functions within the network. Although chip manufacturers have been announcing ISDN products throughout the year, most have not gone beyond the prototype stage. And, many of these chips are being tested in CPE, or terminal equipment, such as digital telephone sets, integrated voice/data terminals, desktop computers and facsimile machines.

"Everybody's still at the starting gate," says Lynn Ditty, product manager of devices at AT&T Technology Systems, headquartered in Berkeley Heights, N.J. Customers have had a couple of months to look over AT&T's ISDN chip entry, dubbed UNITE, which was introduced in July. It is being sampled internally by AT&T's equipment divisions and externally by others. Full production of the UNITE chip is expected to begin in early 1987 at AT&T's Allentown, Pa., semiconductor production plant.

UNITE is a very large scale integrated (VLSI) complementary metal-oxide semiconductor (CMOS) that allows for the integration of voice and data transmissions. Like the majority of ISDN chips being introduced, UNITE adheres to the basic rate, or 2B+D, interface standards set by the International Telegraph and Telephone Consultative Committee. (CCITT is an international committee based in Geneva, Switzerland, that is setting the standards for this universal network.) The preponderance of ISDN trials scheduled in the near future will use basic rate services.

Getting a head start

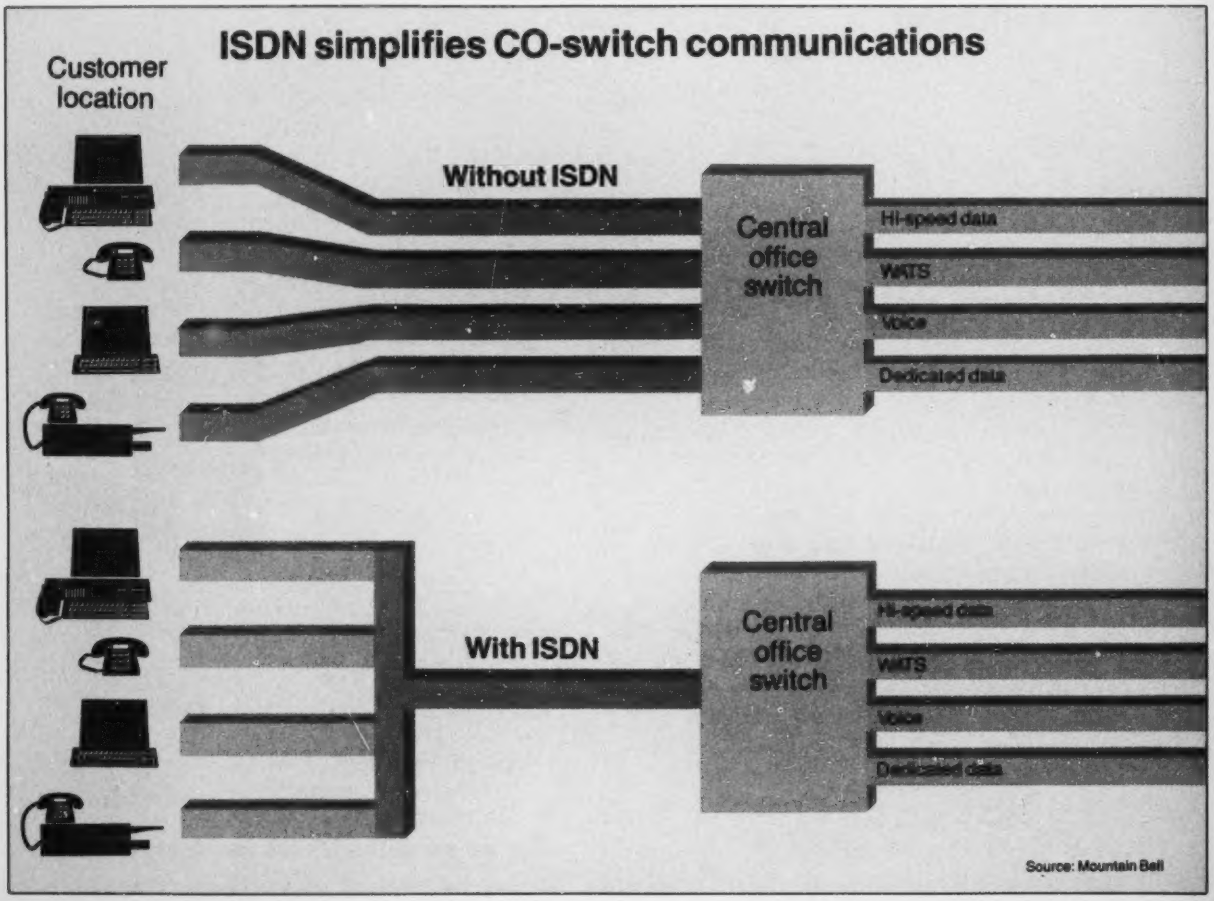
One of the first companies to announce an ISDN family of chips in the United States was Siemens Components Inc. of Iselin, N.J., a subsidiary of Siemens AG, Munich, West Germany. Siemens, which introduced the chip family to the United States in February, got its head start from its entrenchment in the European marketplace, where some standards are more defined than in the United States.

Another company advantage, asserts Helmut Schwab, president of Siemens Components, has been the expertise gained by its close association with another Siemens subsidiary that manufactures communication equipment. Although some equipment manufacturers have concerns regarding buying chips from a vendor whose components are vertically integrated into competing systems, Schwab points out that 80% of his current sales come from the merchant marketplace. As a result, he says, the outside customer is given priority.

Advanced Micro Devices Inc. (AMD), headquartered in Sunnyvale, Calif., is attacking the communication chip market in a big way. Its family of ISDN chips are an important component in the company's strategy to become the No. 1 telecommunication IC manufacturer by 1990. Of the four ISDN chips that AMD has introduced so far, two are designed to be incorporated into terminal equipment and the other two are for use in PBXs or CO switches; all four will be incorporated at the basic rate interface level of an ISDN network.

One way AMD aims to differentiate itself from other ISDN chip vendors is to pack as much capability into its components as possible, says Ronald Ruebusch, director of strategic marketing at AMD's Communications Products Division in Austin, Texas. For example, its Am79C30 (a CMOS, VLSI chip) will perform all the necessary functions that are required at first layer, meaning the physical layer of the Open Systems Interconnect (OSI) reference model — a standard for interconnecting computer and communication equipment. Other vendors, Ruebusch points out, require a set of three to five components to perform the same functions.

Ruebusch expects that initial applications for AMD's ISDN chips will be in terminal equipment from manufacturers such as AT&T, Digital Equipment Corp., NEC Corp. and Wang Laboratories Inc., which are likely to offer ISDN capability with many of their products. In addition to the systems manufacturers, the AMD executive sees a great opportunity in sup-



ISDN simplifies CO-switch communications

Source: Mountain Bell

plying ISDN chips to companies that build plug-in cards for personal computers. Such cards, he believes, will be a significant market for ISDN components early on.

Like Siemens' Schwab, AMD's Ruebusch does not expect to see significant volume production for any products, including components, for another three to four years. However, by the year 2000, he predicts, "the ISDN market will be the largest market for communication ICs."

The ISDN approach at Intel Corp. of Santa Clara, Calif., is a bit different than other IC vendors. Not only is the company offering ISDN chips, it is also developing software that will address several of the seven layers of the OSI model. "The standards established today cover more than the physical layer [layer one of the OSI model], which involves silicon," says Jagtinder Bolaria, ISDN product manager at Intel's Chandler, Ariz., facility. As a result, Intel has chosen to also address levels two and three, where additional standards have been set and where software plays a significant role. Beginning next year, Intel will have software product offerings to address these levels.

Foreign invasion

"Central office switches are the brains and the heart of the public telephone network," says Ronald Weindruch, vice president of sales at Siemens Communications Systems Inc., based in Boca Raton, Fla. These mammoth switches, employed most often by communication carriers to route local and long-distance calls, will act as the hub for the majority of ISDN services in the future.

This major role is a source of comfort for established CO-switch suppliers in the U.S. market. AT&T and Northern Telecom Ltd., the dominant CO-switch companies, face a declining market for the products they now offer. Northern Business Information Inc. predicts that the number of digital CO-switch lines installed annually in the United States will drop more than 10% this year from last year's record of 12 million lines. So AT&T and Northern Telecom are overjoyed at the prospect of a new technology, spurring demand for their products and allowing them to add features that will increase their profitability.

At the same time that their market is shrinking, a number of other CO-switch manufacturers are using ISDN capabilities to break into it. Ericsson Inc., NEC and Siemens all have switches scheduled for ISDN trials to be run by Bell operating companies (BOCs) throughout 1987. The major battle lines, however, are being drawn not so much against the two presiding giants but against those whose market share ranges from very little to nothing. GTE Corp., the No. 3, U.S. CO-switch supplier, would appear to be vulnerable except that most of its switch sales are to its own telephone companies.

AMD's RONALD RUEBUSCH: By the year 2000, he predicts, "the ISDN market will be the largest market for communication ICs"

"All of the telephone companies across the country want at least the possibility of a third supplier . . . to increase competition in price, capabilities and services," suggests Weindruch of Siemens. "But a third vendor will have to get at least 10% of the market for the major players to pay any attention to [that] vendor." Consequently, Weindruch points out, "Our competition over the next few years is not Northern Telecom or AT&T, [but] others trying to be third."

Siemens is making some inroads with its EWSD switch. Having some form of agreement with a majority of the seven regional holding companies (RHCs) — contracts and purchase orders with BellSouth Corp. and Ameritech; letters of intent from Nynex Corp. and Bell Atlantic Corp.; and possibly another letter soon from Southwestern Bell — the wheels are in motion for future sales. Nevertheless, the first EWSD switch shipments are not scheduled to take place until next year, leaving Siemens for now without market share. Undaunted by such an uphill climb, Weindruch believes Siemens has an edge. The EWSD switch, he claims, has been designed with ISDN in mind so upgrading it will simply require, he claims, adding a line card into the switch. "For us," he says, "[upgrading our switch to ISDN] is a yawn."

Ericsson, the Richardson, Texas-based subsidiary of Sweden's L.M. Ericsson Telephone Co., has switch trials scheduled to take place at Southwestern Bell, U.S. West Inc. and Nynex over the next year. In addition to providing its AXE digital CO switch, Ericsson has ISDN product offerings that extend beyond the CO switch to CPE which will play a feature role in ISDN's implementation, including digital telephone sets, the end of the line for ISDN; terminal adaptors, integral in adapting non-ISDN CPE to the network; and PBXs, switchboards located on the customer's premises.

Regardless of the lack of U.S. market share for both Siemens and Ericsson, "we are already paying attention to [these companies]," says Jerald L. Johnson, manager of product planning for digital switching equipment at AT&T Network Systems' Software Center in Lisle, Ill. Both companies are very successful internationally, Johnson points out, and AT&T is not ignoring them.

Like all other CO switch manufacturers, AT&T is using ISDN capabilities as a marketing strategy. It is working, Johnson says, because the BOCs — the chief customers for AT&T's 5ESS CO switch — are basing their purchasing decisions on a vendor's ability to provide for future switching needs. Upgrading a 5ESS to ISDN is a matter of adding two pieces of hardware — a packet switch unit and an integrated service line unit, both inserted into the switch — and a software package that is still in development.

Northern Telecom's claim to fame in the ISDN switch race is that its DMS-100 product is the most feature-rich of all CO switches, claims John Chattoe, vice president of ISDN at Northern Telecom's Toronto location. "No other [vendor] can offer the voice and data features that we do," Chattoe boasts. The cost of such progress, he adds, has been high — eating up a large portion of the comany's research and development budget,

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which this year will represent about 10% of total sales.

Although each of the seven RHCs and their 22 affiliated BOCs are anxious to get their feet wet with ISDN, none is spending heavily on ISDN-related capital equipment purchases. "My job is to try to minimize the amount of money we need to lay out for ISDN," says Wayne Heinmiller, manager of ISDN planning at Ameritech Services in Schaumburg, Ill.

Ameritech is currently spending $1 billion this year converting to digital equipment and installing fiber-optic cable, yet its biggest concern when purchasing a digital CO switch is whether it can provide Centrex services. "ISDN is listed under future needs," he adds, and if a switch is not ISDN capable, that does not mean it will not be purchased. "We service some areas that may never need ISDN," he says.

If customers start banging on Ameritech's doors for ISDN services then that could motivate the company to replace its switches faster than planned. But the company does not expect such demand. "Everyone's talking ISDN," says Heinmiller, "but when you sit with customers, they're rather baffled. There's nothing for them to put their hands on and play with."

Customer confusion is the major impetus behind the ISDN field trials that have been scheduled by each of the RHC's to take place at a number of BOC locations. One of the most extensive trials is scheduled to begin this quarter between Ameritech's Illinois Bell Telephone Company, headquartered in Chicago, Ill., and McDonald's Corp. headquartered in Oakbrook, Ill.

"McDonald's [trial] requires terminal gear for everything under the sun from telephones to computer terminals," says Heinmiller. The AT&T 5ESS central office switch is just one piece of myriad equipment that will be used in this trial. The rest of the equipment is being directly supplied by the CPE vendors themselves. Fujitsu Ltd. and NEC already have announced their involvement in the trial, which is expected to involve several other vendors as well. The CPE needed will include single and multiline digital telephone sets, terminal adaptors and computers.

U.S. West, headquartered in Englewood, Colo., has six trials scheduled. Five ISDN switches will involve the 2B+D basic rate interface; one will use a GTE Omni PBX to provide 23B+D service. The timing of the trials depends, in part, on the availability of ISDN equipment. "There's not much right now," complains Joseph W. Miller III, director ISDN technical development at U.S. West Bell Services in Denver. He expects that communication equipment vendors will not have broad ISDN product lines until mid-1988. What they are offering today are prototypes and interim solutions.

One upcoming U.S. West ISDN trial may turn into a showcase of prototypes. The RHC's Mountain Bell next March will begin an ISDN trial providing ISDN-type services to Intel's Chandler, Ariz., facility. Interestingly, all of the equipment — both the 5ESS switch and the terminal equipment — will be provided by AT&T. The terminal equipment such as telephones, and integrated voice and data terminals, however, will only be on loan. "We don't really have the option to buy it," says Bolaria, Intel's ISDN product manager. Instead, after the trial the equipment will go back to AT&T labs where, Bolaria assumes, any redesign changes will take place.

Although not considered an ISDN trial switch, Nynex and Northern Telecom's joint venture, Intellihub, is a private network service that will offer business customers a great deal of ISDN-like functionality — including integrated voice and data, customer control and an all digital network. "We picture Intellihub as fitting in as an introduction to the capabilities of an intelligent network," explains John Casey, assistant director of strategic technology planning at Nynex.

In addition, Nynex has scheduled several true ISDN trials using the Siemens EWSD switch, which will be configured for ISDN by the time the trials commence. Nynex views such trials as a marketing tool to demonstrate capabilities of ISDN and to test customer interest. "Our trials actually differ somewhat from other regions," Casey says, noting that Nynex will be testing 23B+D as well as 2B+D services. "We're saying primary rate interface is equally important to basic rate interface. One is no more important than the other."

Nynex, like most other RHCs, has an open mind toward ISDN. "If we cannot deliver ISDN — 2B+D interface particularly — to be cost competitive with what customers can purchase today, we don't think ISDN will take off," says Casey. "The market will be driven by our pricing and ability to provide capabilities." ☐

CASE in point: New market spawns instrument changes

As the instrument companies get into software engineering, they are restructuring their traditional markets

By David Card

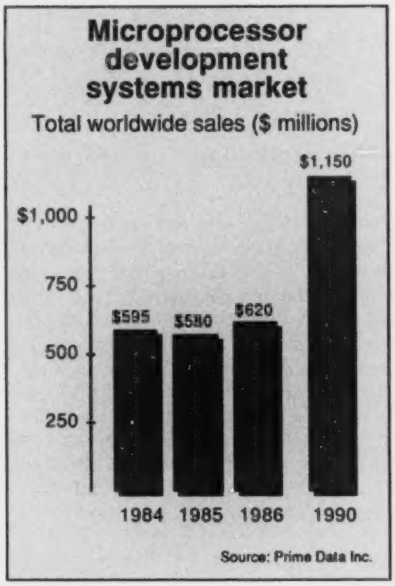
As instrument suppliers move into computer-aided engineering and software design, they are being forced to plug their tools into personal computers and workstations. This process is shaking up once-sturdy markets such as microprocessor development systems and logic analyzers. In the meantime innovative start-ups in all of these markets have shocked some of the old-timers, who are responding by cutting deals rather than trying to squash the little guys.

The development systems business "is increasingly becoming a CASE [computer-aided software engineering] business," says David Dayton, general manager of Hewlett-Packard Co.'s Logic Systems Division. HP has switched its system, which is used to develop embedded software, from a dedicated computer to an add-on box for its workstation. For application software, HP's Colorado Springs-based division has gone to start-up Cadre Technologies Inc. for tools to regulate the software-writing process.

Both HP and archrival Tektronix Inc. now bill development systems as a subset of CASE, which in turn is subsumed under the umbrella of CAE (computer-aided engineering).

Traditionally, microprocessor development systems were dedicated computers sold by the same companies that made the chips. An engineer would plug into a prototype system by replacing the system's controlling microprocessor with an emulator that aped the chip's behavior. He would then use this arrangement to integrate and debug embedded software. Intel Corp. pioneered the development system/emulator field over 10 years ago.

The market for development systems will grow 7% this year to $620 million in sales, forecasts San Jose, Calif., market research firm Prime Data Inc. President Galen Wampler says that unit sales are up, but as suppliers unbundle their systems and allow them to run on general purpose computers, prices are coming down. The end result is sluggish revenue. In 1985, Prime Data ranked Intel No. 1, with HP a distant second, Tek a more distant third and all other suppliers under $30 million in sales.



Microprocessor development systems market

Total worldwide sales ($ millions)

Source: Prime Data Inc.

The traditional development system is dying and the newer PC plug-in version is sick, says James Huffman, engineering manager for Motorola Inc.'s Development Systems operation in Phoenix. The reason: Speed kills, he maintains. Motorola's latest microprocessor, the 68020, runs at a blistering 25 megahertz, too fast for accurate emulation via a cabled-in system, Huffman says.

"We have a much larger charter than just building emulators," Huffman says. "We've set out to put ourselves out of business." By this he means Motorola's job is first, foremost and always to sell chips — not emulators and development systems. Motorola's next microcontroller chip,

still open. "CASE is growing in terms of importance," Reid says, and he does not believe any one company can do the whole job. Partnerships are the way to go. Reid says that he can even conceive of reselling emulators to HP or Tek, although he admits this may be "Intel arrogance creeping in."

More likely partners would be companies like Intergraph Corp. (newly into CAE) and Cadre, Reid says. "But we don't want joint marketing arrangements where it is just a quilting due out in 1988, will have emulator features designed into the chip itself to eliminate most of the cabling hurdle, Huffman says. Motorola is also looking into trying out this technique in its application-specific integrated circuits (ASICs).

Huffman's charter, to promote the sale of chips, has always plagued Motorola's sales of its own development system and emulator. The company encourages competing emulator vendors. For instance, to help get new chips going, Motorola has aided potential competitors' design emulators for the chips by building special versions of the chips with easier accessibility, and passing them on to the emulator companies, Huffman says. "We hope that will help us in the long run," he says, "but in the short term it looks like it hurts." He hints that this philosophy is moving Motorola toward offering CASE tools.

In contrast, Intel has always taken its development system business at face value, competing hard for sales. Intel builds a different custom chip into each of its emulators. The company is not above designing catches into its chips to prevent easy emulation, according to competitors.

This gives Intel the best match on its emulators, claims Gordon Reid, marketing manager of Intel's Development Systems group in Hillsboro, Ore. Reid says that the possibility of Intel selling its emulators to other systems development companies is society," he says, "the partners have to add some value." Evidently the year-old partnership between Intel and CAE supplier Daisy Systems Corp. had too much stitching going on — it still exists but neither side is thrilled with the revenue.

More teaming up

In the general-purpose development system world, suppliers are rushing to add emulators for the latest hot-selling chips. HP's Dayton says his customers are asking that he add Motorola 68020 emulation, followed by an engine-control chip from Intel and a digital signal processor by Texas Instruments Inc. He sees no slacking off in new designs for older 8-bit chips, citing the ubiquitous Z80 as an example. HP must have been too busy moving its very successful development system (15,000 installed) over to its CAE workstation — it still does not offer a 68020 emulator.

Tektronix, like HP, is busy positioning CASE and development systems under the grand heading of CAE. Richard Lemke says that he was recently named president of Tek's CAE Systems Division to tie in instruments, including development systems, to CAE. The primary focus for Tek is hardware design, Lemke says, "but there is no question that we're concerned" about CASE. Although he points out that Tek's CASE staff works alongside its instrument people in the company's Beaverton, Ore., plant, there are signs that the mortar of Tek's united front has not fully dried.

Tek has licensed some software tools, but grows most of its CASE at home. Likewise, Tek has always made development systems, including emulators. Until recently that is. "The margins are highest in the front end," says William David Sharon, marketing manager for Tek's CASE tools. "As you move more toward the traditional emulators, you get more hardware manufacturing costs." Tek recently announced a 68020 emulator, but went to Applied Microsystems Corp. for the hardware to plug into a Motorola microcontroller.

Applied's vice president for business development, Richard Jensen, figures Tek is keeping emulators for the most popular chips in-house, and farming out the rest. His Redmond, Washington-based company was first out of the gate with a 68020 emulator, and ideally Applied would have liked to supply Tek with it as well. However, Jensen is happy with the Tek business and he estimates that the tie will generate $3 million over the next two years. Applied grew nearly 40% this year over last year's $12.8 million in sales.

Jensen counters Prime Data's development system sales estimates, claiming the market will shrink this year. He still thinks Applied is well-positioned at the high end, running off all of the big names in workstations as well as the IBM PC AT, and does not worry about Motorola's built-in emulation putting him out of business. "You can't embed an entire emulator into a chip because of the space it would take up on the silicon," he claims. In fact, the functions that he thinks Motorola would embed were ones that Applied had trouble plugging into, so it would only help. Motorola was an alpha-test site for Applied's latest emulator, and Jensen thinks the cooperation will continue.

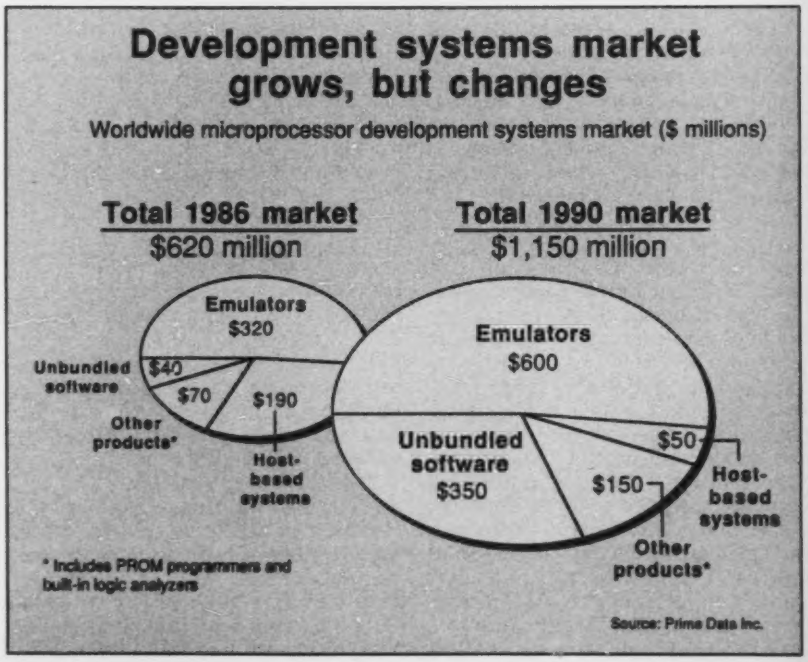
> A CASE company either has to be a start-up that can take risks, or a company big enough to throw resources at the effort

Such cooperation is critical. "In order to play in CASE, you have to be a start-up or an elephant," Jensen says. "A middle-sized company like us would get our lunch eaten alone." Because the market is so new, a CASE company either has to be a start-up that can take risks, or a company big enough to throw resources at the effort, he says.

Jensen gets no argument from $8 million Nastec Corp., based in Southfield, Mich. Vice president Albert Connor claims Nastec coined the term CASE back in 1982, but was in the job of "missionary sales," or trying to explain the market to potential customers, before the big guys legitimized it.

Nastec was doing some work for RCA Corp. last year, but RCA wanted hardware other than Nastec's Convergent Technologies Inc. computer. Connor got some specifications from RCA and took them to Digital Equipment Corp., whose VAX minis are an RCA mainstay. The joint DEC/Nastec team beat out 16 other bidders, Connor claims, for a $100,000 contract. But this money is peanuts compared to the potential RCA business, Connors says.

Nastec has since joined DEC's Cooperative Marketing Program, so DEC salesmen can recommend Nastec software. Tek, which Connor claims did not make the final cut at RCA, has signed an even tighter agreement with DEC — its CASE unit belongs to what DEC calls the Systems Cooperative Marketing Program, which allows some overlapping sales. ☐


Development systems market grows, but changes

Worldwide microprocessor development systems market ($ millions)

* Includes PROM programmers and built-in logic analyzers

Source: Prime Data Inc.

Overcapacity in the U.S. capacitor industry

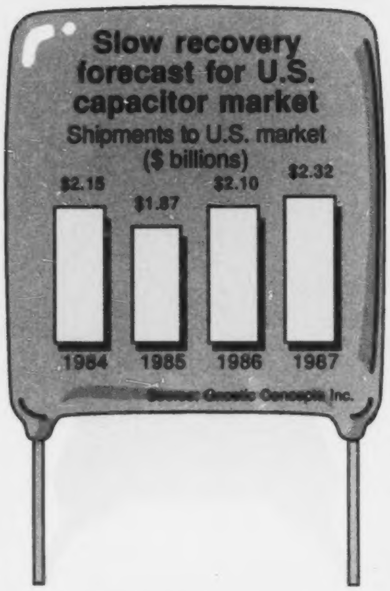
Debate rages over prospects for 1987. Will new foreign ventures in the U.S. generate new business?

By Alden M. Hayashi

Last June, Kyocera Corp. of Kyoto, Japan, officially opened a capacitor manufacturing plant in Vancouver, Wash. At a cost of $30 million, the facility will eventually be manufacturing 300 million capacitors a month. With the capacitor industry in the throes of a major recession, Kyocera's investment strategy has been questioned by some. Kyocera executives, however, claim a strong market next year will busy the new factory. "The worst is over. Next year we're going to see some real growth," predicts Michael Drotar, a product manager for Kyocera.

Others concur. Last year, the U.S. capacitor market fell 13%, from $2.15 billion in 1984 to $1.87 billion, according to Gnostic Concepts, a San Mateo, Calif., market research firm. This year won't be as disastrous, says Robert A. Patrick, vice president of marketing and sales for Mallory Capacitor Co. of Indianapolis. "We expect 1986 U.S. capacitor shipments to be flat [0% growth] to down 5%," he says. Next year will be much better, says Patrick: "1987 U.S. capacitor shipments are expected to grow 10% to 12%." Charles E. Volpe, general manager for Kemet of Union Carbide Corp., is also bullish. "I'm fairly optimistic about '87. I see some health coming back," he says. Adds Arch Martin, a marketing manager for AVX Corp. of Great Neck, N.Y.: "I see next year as being pretty good."

But some in the industry are not so optimistic. "There is a possibility for flat growth in '87. It's not a probability, but it *is* a possibility," says Donald McGuinness, executive vice president in charge of passive components for Sprague Electric Co., headquartered in Lexington, Mass. McGuinness' cautiousness comes from experience. "I've been in this business for 27 years and this is the longest down market ever," he recalls. Adds George Stuart, product manager of industrial electronic capacitors for General Electric Co., "We're looking at next year as a very, very tough year, as if this year wasn't tough enough." GE sells capacitors in the high-voltage utility, air conditioning and lighting and industrial markets. "We are anticipating those markets to be flat at best and possibly down in '87," says Stuart.



Source: Gnostic Concepts Inc.

The industry needs a strong 1987 to correct a serious overcapacity problem

What a mess

Unfortunately, the industry needs a strong 1987 to correct a serious overcapacity problem. As with its semiconductor brethren, capacitor vendors also increased their production capacity in 1983-1984 as the market, at that time, surged. But, from late 1984 on, the market soured and manufacturers were stuck with excess plant capacity. "It was just a mess," remembers Kyocera's Drota. At present, U.S. plants are still only operating at around 65% to 70% of capacity, estimates Sprague's McGuinness. Says Kemet's Volpe: "There's certainly still a lot of excess capacity left in the industry."

Emmitt Graham, an analyst with Gnostic, expects the overcapacity problem to continue through at least late next year. "Particularly in multilayer ceramic (MLC) chip capacitors, capacity will continue to lead demand. The Japanese are adding capacity at a substantial rate," says Graham.

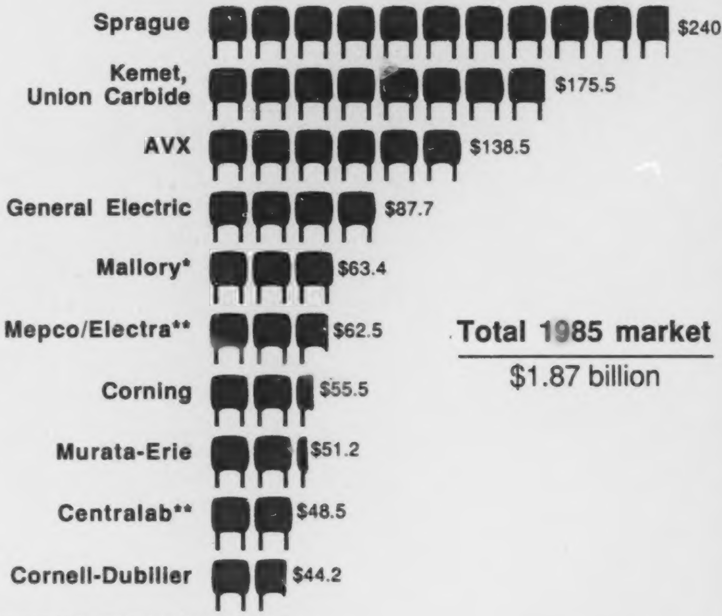
Capacitor vendors cite the same reasons for their overcapacity problem as their semiconductor counterparts do: customer overbookings in 1983-84 and the subsequent malaise of the computer industry. Indeed, the computer industry accounted for just 16% of all U.S. factory sales of capacitors in 1985, down from 21% in 1984, says McGuinness.

Capacitor vendors are counting on an expected recovery in the computer industry to help bolster capacitor sales next year. In fact, despite its recent sluggishness, the computer industry, along with the telecommunication industry, will be the end-user industries with the highest growth, claims McGuinness. Adds Mallory's Patrick: "In 1987, we expect to see the strongest growth in the communication and computer equipment markets as the result of expected recovery in capital investment for this type of equipment." And customers have since burned off their excess inventories, says Gnostic's Graham. "The inventory situation is well under control now," he claims.

Other factors might also help.

The top ten U.S. capacitor makers

1985 Shipments to the U.S. market ($ millions)



* Does not include Westlake Capacitor sales

** Mepco/Electra and Centralab merged in 1986

Source: Gnostic Concepts Inc.

Kemet's Volpe says he sees one positive trend: systems companies (customers of capacitors) doing more manufacturing in the United States. "We still have customers moving offshore but not as much as we did last year. And some of them are starting to come back home. The trend toward offshore manufacturing hasn't stopped but it has slowed down," says Volpe.

In addition to U.S. firms, foreign companies are also turning to the United States for manufacturing. The Japanese, in particular, seem eager to expand their manufacturing in the United States, due in part to the recent U.S.-Japan trade friction and the effects of the high-valued yen. Last September, Matsushita Electric Industrial Co. Ltd., headquartered in Japan, began manufacturing televisions in its new Vancouver, Wash., facility.

Onshore versus off

Some U.S. capacitor vendors, however, question whether the increase in foreign company manufacturing in the United States will lead to more business for U.S. companies. "I would be very much surprised if we went to call on a Japanese company in the U.S., and they were receptive," says Kemet's Volpe. Adds Sprague's McGuinness: "We're not counting on any extra business." McGuinness explains that foreign companies will probably buy parts from their fellow countryman suppliers. He recalls a similar situation with his company back in the 1960s when IBM expanded its operations in Europe. "Everywhere IBM went, we just put up a plant right next to them," remembers McGuinness.

Because of this trend of increased U.S. manufacturing by Japanese companies, Kyocera's Drotar says: "It [our plan to open a capacitor plant in the U.S.] is unfolding and blossoming like a flower." Kyocera's ambitious goal is to own 30% of the U.S. ceramic capacitor market by 1990. The company currently controls 10% of the market, according to Drotar.

Other foreign companies may follow Kyocera's lead. "We see the U.S. as our highest opportunity growth market for the future," says John Davidson, president of Rifa Inc., a wholly owned subsidiary of L.M. Ericsson, headquartered in Sweden. Davidson says Rifa has just begun a more aggressive sales and marketing program in the United States. He is planning for Rifa's sales to grow annually by 30%.

Davidson now has a better chance of meeting his goal because prices in the industry have recently begun to stabilize. According to Kyocera's Drotar, prices of ceramic capacitors fell 30% from 1984 to 1985. But from 1985 to 1986, prices only dropped 10%. "There has been a firming of prices," agrees Kemet's Volpe, who adds that prices for MLC and tantalum capacitors have stopped falling. And some companies have even begun to raise prices. Sprague recently increased the prices for its wet foil and tantalum capacitors as well as for

A maturer market strategy

Sprague Electric Co., the leader in the U.S. capacitor market, has undergone a fundamental change in philosophy. Owned by Penn Central Corp., Sprague has adopted a more mature strategy to fit the now mature capacitor industry.

Back in the 1970s, Sprague's philosophy was: "Don't be late with an investment," recalls Donald McGuinness, executive vice president in charge of passive components. Thus the company hurriedly entered into new markets and expanded in existing ones. But now that the capacitor industry has matured, Sprague is now judiciously targeting return on investment and profitability as the key criteria for investment decisions.

"We're not saying [anymore]: 'Throw money there, we've got to get the lead.' But what we are now saying is: 'Let's pick the places where we can be No. 1. Let's not chase after market share for the sake of market share,'" says McGuinness.

Sprague is not the only company with this new attitude. "Everyone in the industry is asking: 'Do I really want more market share?,'" says Arch Martin, marketing manager for AVX Corp. of Great Neck, N.Y. Adds McGuinness: "If you have a big market share and you're not making any money, that's pretty stupid." ☐

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some of its aluminum and film capacitor line, according to McGuinness.

Reduced lead times

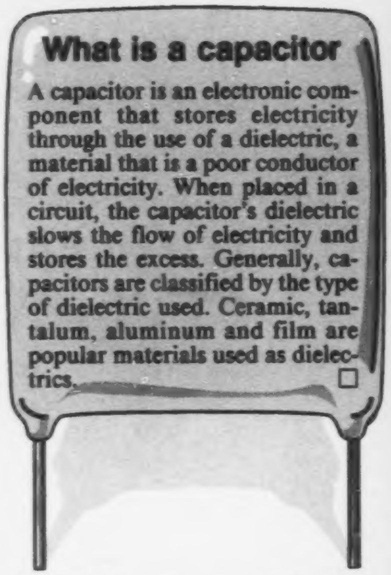
Lead times have also stabilized. According to AVX's Martin, lead times have remained constant for the past year. Vendors are now working on reducing their lead times, not through added capacity, but through closer relationships with customers. Through the installation of programs such as just-in-time (JIT) delivery, vendors are hoping to slash lead times to just a few weeks. "Customers aren't going to give you big guaranteed orders anymore if your lead times are too long," says Sprague's McGuinness. Kemet's Volpe sees a hidden blessing in programs such as JIT delivery. As U.S. customers install JIT delivery programs, they will tend to favor U.S. capacitor manufacturers as opposed to foreign ones, reasons Volpe.

This favoritism will play an important role as customers begin to limit the number of their suppliers. "Every one of our major customers is on a reduction-of-supplier program. If a customer had four suppliers before, he may have just one or two now," says Volpe. Adds Sprague's McGuinness: "With a lot of customers, they just want one supplier."

Another industry trend is the evolution toward surface-mounted capacitors. "The move to surface mount will dominate the industry in the coming years," predicts Kemet's Volpe. Some vendors are already experiencing the change. "We're starting to get the real inquiries and customers are now placing large orders of 50 million [units] instead of 5,000," says Kyocera's Drotar. According to him, "All the major disk drive manufacturers have surface mount programs in effect and the computer industry is finally going surface mount." Because of this, the market for surface-mounted ceramic capacitors will grow five times as fast as the overall ceramic capacitor market, claims Drotar.

The surface mount evolution will not benefit all types of capacitors equally. "Mono[lithic ceramic] and tantalum capacitors will be the big winners because it's easier to convert them," says Sprague's McGuinness. According to him, wet electrolyte capacitors such as aluminum ones will be very difficult to convert to surface mount.

If McGuinness is right, ceramic and tantalum capacitors could gain further share in the overall market. Already, both types of capacitors control 65% of the market on a dollar basis, up from 47% more than a decade ago, according to the Electronic Industries Association of Washington D.C. In contrast, the market share for aluminum capacitors has fallen from 22% to 12% during the same time period.



What is a capacitor

A capacitor is an electronic component that stores electricity through the use of a dielectric, a material that is a poor conductor of electricity. When placed in a circuit, the capacitor's dielectric slows the flow of electricity and stores the excess. Generally, capacitors are classified by the type of dielectric used. Ceramic, tantalum, aluminum and film are popular materials used as dielectrics. ☐

But vendors of the other types of capacitors are not quitting. Using a proprietory pre-aging foil process, West German giant Siemens AG says it will begin manufacturing chip film capacitors in surface mount form this year. Volume production will commence in 1987. According to Rudy Strasser, capacitor product marketing manager for Siemens Components Inc., a subsidiary of Siemens AG, about a quarter of all chip film capacitors will be surface mounted within the next five years. Currently, virtually none of these capacitors are surface mounted.

But still, "mono[lithic ceramic capacitor] chips are the fastest growing type of capacitor," claims McGuinness. According to him, the market for this type of capacitor will have a long-term growth in excess of 10% next year. And the market for tantalum capacitors will grow by 7% to 8% on a long-term basis, he adds. On the other hand, the market for aluminum, film and other types of capacitors will grow no more than 5%, claims McGuinness. ☐

Last month, Union Carbide announced it would sell Kemet (the No. 2 U.S. capacitor vendor). Sprague (the No. 1 U.S. capacitor vendor), among several other capacitor manufacturers, was reportedly interested in the purchase although Union Carbide had not yet issued any offering letters.

Japanese electronics: Alive in '85, mixed in '86

The Japanese electronics industry saw earnings take a nosedive last year, and that was before the rise of the yen

By Paula Doe

Japan's big producers maintained strong growth in electronics sales in 1985, but they paid for it with sharply reduced earnings. Electronics sales at the top 15 Japanese companies were up 22%, more than twice the 10% increase at the top 15 U.S. electronics producers. But at the same time, Japanese earnings were correspondingly down 20%, more than twice the 7.6% drop at their U.S. counterparts.

Unconcerned with racking up short-term gains for shareholders, Japanese companies seldom show fat profits. But 1985 earnings were grim, even by Japanese standards. Unconsolidated earnings at the big five Japanese computer and semiconductor makers — Fujitsu Ltd., NEC Corp., Hitachi Ltd., Toshiba Corp. and Mitsubishi Electric Corp. — dropped an average 46%. (Unconsolidated refers to financial figures for the parent company only; it does not refer to earnings from subsidiaries or joint ventures in which the parent company holds a controlling interest.) Total consolidated earnings for the top 15 Japanese electronics producers, including subsidiaries, were down 20.1%. Margins for the top 15 were cut in half, as profits fell from 6% to 3% of sales. Return on equity slipped 24%, to an average 7.9%. Return on investment was off 20%, to 6.8%.

Yet things could have been worse in the Japanese electronics business — and assuredly, they will be before the year is out. Results for 1985 were cushioned at most Japanese companies by a fat first half. It wasn't until the second half of the year that the electronics slump finally hit Japan, and the yen began its climb against the dollar. The Japanese managed to protect their exports through the end of the year, despite the expensive yen. Exports at the big electronics producers had fallen less than 2% on average (unconsolidated) by the end of fiscal 1985, which ended in March 1986 for most Japanese companies.

Though the high yen devastated Japanese producers' profits, it makes all dollar-denominated figures from Japan look great. The 27% rise in the yen between March 1985 and March 1986 makes all the Japanese companies' dollar results look 27% better, both for revenue and profits. In dollars, the top 15 Japanese electronics companies appear to have a respectable 8.5% increase in earnings on 33% growth in revenue.

At 180 yen to the dollar (the official exchange rate, as of March 1986, prior to last summer's slide to 150 yen to the dollar), the big Japanese electronics companies look even bigger. Six Japanese companies now have electronics revenue of $7 billion or more. Only three did in 1984. And five of the top eight companies are now Japanese on a combined ranking of U.S. and Japanese companies' electronics sales. No Japanese company, of course, approaches $50 billion IBM, but Matsushita Electric Industrial Co., at $17.9 billion in electronics sales, is now bigger than AT&T and all other U.S. electronics companies. Only IBM, AT&T and General Motors

Top Japanese electronics companies

	Electronics sales ($ million)		Total sales ($ million)		Net income ($ million)	
Company	1985	1984	1985	1984	1985	1984
Matsushita	$17,889	$14,518	$28,071	$19,356	$1,369	$976
NEC	12,361	9,258	12,611	9,258	261	275
Hitachi	12,222	9,865	27,836	20,553	835	861
Toshiba	8,889	6,031	18,739	13,706	330	353
Fujitsu [1]	8,733	6,375	9,444	6,375	238	363
Sony	7,333	4,973	7,995	5,236	406	291
Sanyo Electric	4,767	3,563	8,433	5,904	200	180
Mitsubishi	4,167	3,345	11,078	8,306	186	192
Sharp [1]	4,150	4,264	6,667	4,763	194	163
Canon	3,450	2,216	5,311	3,388	206	143
Ricoh	2,838	1,914	3,300	2,229	83	69
Oki [1]	2,272	1,673	2,317	1,706	6	37
Tokyo Sanyo [1,2]	2,133	1,380	3,050	1,971	83	73
Alps [1]	1,900	1,461	2,000	1,539	50	73
Pioneer	1,816	1,253	1,894	1,306	-17	33

[1] Consolidation by Japanese accounting conventions, which differ slightly from U.S. Securities and Exchange Commission rules used by other companies.

[2] Sanyo Electric Company Ltd. owned 20% of Tokyo Sanyo Electric Company Ltd. for the fiscal year ending November 1985.

Composite performance: Japan vs. U.S. electronics companies

	Japan top 15	U.S. top 15	U.S. top 200
Electronics revenue for 1985 ($ billions)	$94.8	$148.8	$267.8
Change from previous year	22%*	+10%	+4.5%
Total revenue for 1985 ($ billions)	$148.7	$284.9	$797.8
Change from previous year	3.5%*	+7%	+2.7%
Net income for 1985 ($ billions)	$4.4	$17.2	$35.4
Change from previous year	-20.1%*	-7.6%	-23.7%
Net income as a percentage of sales	3%	6%	4%
Return on equity	7.9%	9.5%	11.8%
Return on investment	6.8%	7.7%	8.7%
Revenue per employee	$173,300	$87,600	$110,800
Net income per employee	$4,700	$4,500	$5,000

* Percentage change in yen

Source: ELECTRONIC BUSINESS, Nomura Securities International Inc.

JAPANESE COMPANIES maintained sales growth by squeezing profits. In the United States, the trend was the same, but less extensive

Corp. — thanks to its acquisition of Hughes Aircraft Co. — are still bigger than at least some of the big Japanese companies Matsushita, Hitachi, NEC, Toshiba and Fujitsu.

The strong yen also made strong showings by particular companies look even stronger. Toshiba leaped from No. 13 last year to No. 7 this year on the combined rankings, Sony from No. 16 to No. 11.

Japan's fabled productivity, as measured by dollar sales per employee, gets an artificial 27% boost as well. At 180 yen to the dollar, the top 15 Japanese electronics companies got two times the sales out of each worker as did the U.S. top 15, and 1.6 times the sales per employee average for all the 1985 ELECTRONIC BUSINESS 200. If the exchange rate had remained at last year's 245 yen to the dollar, however, the Japanese would have only had a 47% advantage over the U.S. top 15, and only a 16% edge over the 200.

ELECTRONIC BUSINESS collects the top Japanese electronics companies' financial results from Japanese financial reports, available long before most Japanese companies release their English language, U.S.-style annual report for the year. The companies' consolidated revenue and earnings, and all parent-company-only figures come from Japanese company reports, press releases and the directory *Kaisha Shikiho*, published quarterly by *Toyo Keizai Shuppansha*. Consolidated electronics sales and productivity figures are calculated by ELECTRONIC BUSINESS with the help of Nomura Securities International Inc., the New York branch of a leading Japanese investment house.

Though the data supplied strictly by Japanese sources is more timely, most of it is for the parent company only, as required by Japanese law and accounting conventions. Subsidiaries, even if 50% or more controlled by the parent, report as separate companies in Japan. Detailed unconsolidated figures are reported to the Ministry of

Net income as a percentage of sales		Return on equity[3]	Return on investment[3]	Sales per employee	Net income per employee	Parent company only			Fiscal year end
1985	1984					Sales ($ million)	Net income ($ million)	Exports	
5%	8%	10%	10%	$209,500	$10,200	$19,023	$620	37%	11/85
2%	3%	11%	7%	131,600	2,700	10,947	295	32%	3/86
3%	4%	11%	9%	169,600	5,100	16,686	489	33%	3/86
2%	3%	9%	7%	156,200	2,800	13,998	300	29%	3/86
3%	6%	6%	4%	117,000[4]	2,900[4]	7,942	164	22%	3/86
5%	6%	11%	11%	178,000	9,000	5,952	272	71%	10/85
2%	3%	8%	8%	331,600	7,900	5,822	83	61%	11/85
2%	2%	6%	5%	155,000	2,600	10,117	136	27%	3/86
3%	3%	10%	8%	231,500[3]	8,400[3]	5,307	193	60%	3/86
4%	4%	9%	8%	161,000[4]	6,200[4]	3,194	133	75%	12/85
3%	3%	7%	7%	132,000	3,300	2,722	67	38%	3/86
2%	2%	2%	1%	125,000[4]	300[4]	2,011	11	28%	3/86
3%	4%	9%	9%	212,000[4]	5,800[4]	2,978	83	48%	11/85
3%	5%	8%	7%	160,000[4]	4,000[4]	1,578	50	24%	3/86
-1%	3%	1%	1%	128,800	-900	1,444	11	43%	9/85

[3] Parent company only.

[4] Consolidated employees estimated from 1984 consolidated figures and 1985 parent company only figures.

Sources: ELECTRONIC BUSINESS, Nomura Securities International Inc.

Finance and released to the public within three months of the end of the fiscal year, which ends in March for most Japanese companies. But consolidated financial figures, which combine results from the parent company and all subsidiaries in which it owns controlling interest, trickle out more slowly.

Most major companies now report consolidated sales and earnings totals when they release their Japanese parent-company-only results, but further details do not come out until the publication of the English language annual report. The Japanese companies listed on one of the U.S. stock exchanges get these reports out reasonably promptly, as U.S. law requires, but the majority of even the big Japanese companies take at least six months after the end of the fiscal year to get out these U.S.-style numbers. And some that don't sell stock in the United States never put together U.S.-style detailed consolidated financial reports at all. □

Japanese computer firms had few complaints last year

Computer sales showed double-digit growth in 1985, good news for Japanese subsidiaries of U.S. companies

The following article is based wholly on a previously untranslated article about the Japanese computer industry which appeared in Computopia *magazine in August.* Computopia *is published in Tokyo by Computer Age Company Ltd.*

The Japanese computer market continues to perk right along at its steady double-digit growth rate. But last year, for a change, American companies were the ones who made money.

The nine major computer companies in Japan averaged 14% sales growth in 1985. Forecast for 1986: about the same, as steady growth in the Japanese market counterbalances a drop in exports.

The expensive yen gave U.S. computer companies a boost in Japan in 1985. The five major Japanese computer makers, Fujitsu Ltd., NEC Corp., Hitachi Ltd., Toshiba Corp. and Mitsubishi Electric Corp., saw their unconsolidated pretax profit plummet 46%, on average, for the year. But the big four Japanese subsidiaries of U.S. computer companies, IBM Japan, Nippon Univac Kaisha Ltd., NCR Japan Ltd. and Burroughs (Japan), increased their pretax earnings an average 15%.

IBM Japan earned pretax profits of a healthy 15% of sales, in sharp contrast to 3% at Fujitsu and 5% at NEC. But the Japanese companies continued to sell more computers in Japan than IBM. Fujitsu maintained its dominance, with computer sales in Japan of $4.7 billion (¥180=$1) in 1985, compared to $3.9 billion for NEC, and $3.7 billion for IBM. But if exports are included in the sales totals, IBM Japan sold more computers overall ($5.1 billion) than NEC ($4.5 billion). Slightly faster growth at Big Blue's Japanese subsidiary meant it gained a little on Fujitsu for total sales, but still remained some 12% behind its rival's $5.7 billion.

Last year's Japanese computer market was spurred by healthy demand for the new generation of giant mainframes, IBM's 3090 Sierra and the Japanese computer makers' competing products. Fujitsu says it received 261 orders for its big VP series mainframe in 1985, twice the number as the year before, for 60% more revenue. Hitachi has orders for 112 of its giant mainframe, while NEC has orders for 94.

The personal computer and office automation market continued strong. NEC continued to dominate the personal computer market, with sales up 19% to $1.3 billion.

Fastest growing of the major computer makers last year was Toshiba. That company's 27% spurt in computer sales came largely from strong growth in sales of peripherals (up 40%) and word processors.

At the other end of the spectrum, Mitsubishi Electric's plummeting exports resulted in no growth in its computer sales at all. A prime factor: A patent dispute with Tandon Corp. over disk drives.

In the broader category of office automation equipment, which includes computers as well as such other electronic office equipment as copiers, facsimile machines and word processors, U.S. companies in Japan had

Top Japanese computer makers

Company	Computer division sales ($ millions)	Growth rate 1985/1984	Exports ($ millions)	Exports as a percentage of total sales	Projected 1986 sales ($ millions)	Projected growth rate 1986/1985
Fujitsu	$5,711.1	+17.6%	$1,012.8	17.7%	$6,500.0	+13.8%
IBM Japan	5,080.6	+19.0%	1,421.7	28.0%	N/A	+15.0%
NEC	4,516.7	+23.0%	644.4	14.3%	5,277.8	+17.0%
Hitachi	3,333.3	+12.8%	566.7	17.0%	3,888.9	+16.7%
Toshiba	1,627.8	+27.0%	288.9	17.7%	1,944.4	+19.4%
Mitsubishi	916.7	0.0%	165.0	18.0%	988.9	+8.0%
Nippon	750.6	+11.2%	0.0	0.0%	833.3	+11.0%
NCR Japan	567.2	+13.6%	102.2	18.1%	633.3	+11.7%
Burroughs	453.9	+1.3%	45.6	10.0%	544.4	+20.0%

Source: Computopia magazine

Top Japanese computer and office automation equipment vendors

Company	Information processing equipment sales ($ millions)	Total sales ($ millions)	Percentage change from 1984	Pretax profit ($ millions)	Percentage change from 1984	Fiscal year ends
Hitachi	$7,863.90	$16,685.0	-0.7%	$877.80	-38.3%	3/86
Fujitsu	5,711.1	7,941.1	+10.6%	210.0	-67.8%	3/86
IBM Japan	5,080.6	5,080.6	+18.9%	748.3	+31.9%	12/85
NEC	4,605.6	10,946.7	+4.0%	525.0	-25.0%	3/86
Sharp	3,509.4	5,306.7	+5.0%	357.2	+1.4%	3/86
Matsushita	2,655.0	19,022.8	+5.0%	279.4	+6.5%	11/85
Mitsubishi Electric	2,601.1	10,116.1	-2.1%	223.9	-53.0%	3/86
Ricoh	2,566.7	2,722.8	+8.5%	142.2	-12.0%	3/86
Fuji Xerox	1,928.9	1,928.9	+21.0%	185.0	+6.0%	11/85
Canon	1,668.9	3,196.1	+18.5%	236.1	+9.8%	12/85
Toshiba	1,627.8	13,997.2	-0.2%	446.7	-45.0%	3/86
Oki	1,095.6	2,008.9	-0.1%	7.8	-92.0%	3/86
Sanyo Electric	925.0	5,820.0	+5.6%	324.4	+4.8%	11/85
Nippon Univac	750.6	750.6	+11.0%	27.8	-4.0%	6/85
Casio Computer	746.7	1,312.2	+12.0%	71.7	-21.0%	3/86
Seiko Epson	584.4	1,461.1	+49.5%	N/A	N/A	3/86
Commodore Japan	583.3	583.3	+5.2%	N/A	N/A	6/86
Burroughs	453.9	453.9	+1.0%	40.6	+10.0%	11/85
NCR Japan	445.6	567.2	+13.6%	101.7	+21.0%	11/85
Tokyo Electric	363.9	856.7	-13.0%	46.7	-31.0%	3/86
Panafacom	303.9	303.9	+24.0%	12.8	N/A	3/86
DEC Japan	243.3	243.3	+42.0%	13.9	N/A	6/86
Yokogawa Hewlett-Packard	232.8	582.2	+17.0%	N/A	N/A	10/85
Nihon Business Computer	166.7	166.7	+36.0%	N/A	N/A	3/86
Seikosha	158.3	527.8	+2.0%	N/A	N/A	3/86
Japan Data General	141.7	141.7	+79.0%	44.4	-27.0%	10/85
Uchida Yoko	123.9	562.2	+5.0%	18.3	+17.8%	7/85
Sony	118.9	5,951.7	+17.0%	505.6	+13.0%	10/85
Olivetti Japan	117.8	130.6	+11.9%	N/A	N/A	12/85
Sord	65.6	65.6	-37.0%	-10.0	N/A	3/86

Nonconsolidated results. For parent company or specified subsidiary only

Source: *Computopia* magzine

an encouraging year — the fastest growing companies all sold U.S. products. Nippon Data General, Japan Business Computer and Yokogawa Hewlett-Packard outpaced the competition, thanks to the advantageous exchange rate and the right products.

OA for the U.S.A.

Fastest growth of the top 30 office automation (OA) companies was achieved by Nippon Data General. The company saw an impressive 79% increase in revenue. But like a true Japanese company, the U.S. subsidiary suffered a 27% drop in profits, as its exports of the portable Data General/One computer to the United States got walloped by the soaring yen.

Sales of computer and office automation equipment at Nihon Business Computer climbed 36% in 1985, due to the dealer's healthy sales of IBM equipment, particularly the IBM System 36.

Yokogawa Hewlett-Packard increased its revenue 17%, thanks to strong sales of Hewlett-Packard's Unix-based engineering workstations. The HP 9000 series and the HP 9807 did well, and the technical workstation 9300, introduced last September, was especially popular.

Seiko Epson Corp's 17% increase in sales was due to the merger of Seiko and Epson.

Worst performance honors among the office automation makers go to personal-computer maker Sord, in its first year under Toshiba's wing. Sord undertook a major revision of its product development system and wrote off inventories, resulting in a 37% drop in sales and a loss of $6.5 million.

The big Japanese computer makers remain cautiously optimistic about the rest of fiscal 1986. Though they expect exports to continue to be hurt by the high yen, they count on healthy domestic demand to result in a net 14% to 15% growth in computer sales. NEC expects its earnings to be up 12% from sales of its big ACOS System 1000 mainframes to Honeywell Inc. and Groupe Bull. Hitachi expects to increase its exports 17% in 1986, with strong sales overseas of its 5-megabyte disk drive equipment. Fujitsu, however, projects a 10% drop in exports. ☐

LEADTIME INDEX

Electronic component leadtimes

Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average	Last month's average
TRANSFORMERS								
Toroidal	0	27	46	27	0	0	8.5	9.3
Pot-Core	8	33	34	25	0	0	7.3	9.6
Laminate (power)	7	20	40	33	0	0	8.9	6.6
CONNECTORS								
Military panel	0	0	75	0	0	25	13.8	13.1
Flat/Cable	22	39	30	9	0	0	4.6	4.6
Multipin circular	0	31	54	15	0	0	7.4	10.4
PC	7	33	40	20	0	0	7.1	5.8
RF/Coaxial	18	35	35	12	0	0	5.4	5.9
Socket	30	25	30	15	0	0	5.3	5.3
Terminal blocks	15	35	30	20	0	0	6.3	4.4
Edge card	10	35	45	10	0	0	5.9	7.3
Subminiature	20	13	53	7	7	0	7.3	6.4
Rack & panel	9	9	55	18	9	0	9.8	7.3
Power	8	31	38	15	8	0	8.2	6.0
PRINTED CIRCUIT BOARDS								
Single-sided	0	48	52	0	0	0	5.1	4.8
Double-sided	0	50	50	0	0	0	5.0	5.8
Multilayer	0	14	62	24	0	0	9.0	8.8
Prototype	0	83	17	0	0	0	3.0	2.9
RESISTORS								
Carbon film	56	13	19	12	0	0	3.6	3.6
Carbon composition	46	17	25	12	0	0	4.3	4.6
Metal film	42	21	33	4	0	0	3.8	3.9
Metal oxide	27	27	37	9	0	0	4.9	4.5
Wirewound	18	41	29	12	0	0	5.1	6.3
Potentiometers	12	46	27	15	0	0	5.5	6.6
Networks	18	27	41	14	0	0	6.0	7.6
FUSES	48	35	17	0	0	0	2.1	3.7
SWITCHES								
Pushbutton	14	33	34	19	0	0	6.4	5.1
Rotary	5	30	35	30	0	0	8.2	6.9
Rocker	20	30	35	15	0	0	5.8	5.9
Thumbwheel	0	42	42	16	0	0	6.8	8.3
Snap action	17	33	42	8	0	0	5.3	4.9
Momentary	7	36	43	14	0	0	6.4	4.6
Dual in-line	15	31	38	16	0	0	6.2	3.7
WIRE AND CABLE								
Coaxial	35	41	18	6	0	0	3.2	2.8
Flat ribbon	27	41	23	5	4	0	4.5	3.8
Multiconductor	35	24	29	6	6	0	5.3	3.8
Hookup	41	41	11	4	3	0	3.7	1.9
Wire wrap	43	29	21	7	0	0	3.4	3.1
Power cords	21	34	34	7	4	0	5.4	3.8
Other	22	34	22	22	0	0	6.0	7.4
POWER SUPPLIES								
Switching	6	18	41	35	0	0	9.3	9.4
Linear	14	21	43	22	0	0	7.3	8.0
CIRCUIT BREAKERS	19	38	12	31	0	0	6.8	6.8
HEAT SINKS	29	33	29	9	0	0	4.5	5.1

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average	Last month's average
RELAYS								
General purpose	30	15	35	20	0	0	6.3	6.2
PC board	7	27	33	33	0	0	8.5	6.8
Dry reed	10	20	30	40	0	0	9.2	8.2
Mercury	10	20	40	30	0	0	8.4	10.1
Solid state	6	19	38	31	6	0	10.0	8.9
DISCRETE SEMICONDUCTORS								
Diode	34	32	20	11	3	0	4.8	4.5
Zener	23	37	20	17	3	0	5.9	5.5
Thyristor	18	18	41	17	6	0	8.0	7.1
Small signal transistor	24	19	38	14	5	0	7.0	6.7
FET, MOS	13	13	47	20	7	0	8.9	8.6
Power, bipolar	21	16	42	16	5	0	7.6	7.3
INTEGRATED CIRCUITS, DIGITAL								
CMOS	21	21	31	24	0	3	7.8	7.6
TTL	29	25	25	17	0	4	6.5	7.5
LS	29	21	29	17	0	4	6.7	7.7
INTEGRATED CIRCUITS, LINEAR								
Communication/circuit	8	15	46	31	0	0	8.9	7.7
OP amplifier	21	29	21	29	0	0	6.9	9.2
Voltage regulator	28	32	20	20	0	0	5.4	8.2
MEMORY CIRCUITS								
RAM 16K	25	31	19	25	0	0	6.1	7.1
RAM 64K	29	29	24	18	0	0	5.3	6.2
RAM 256K	25	25	31	19	0	0	6.0	7.5
ROM/PROM	20	13	40	27	0	0	7.7	8.3
EPROM	23	32	32	13	0	0	5.4	7.4
EEPROM	20	27	33	20	0	0	6.4	10.8
DISPLAYS								
Panel meters	16	15	46	23	0	0	7.7	8.3
Fluorescent	0	11	56	33	0	0	10.0	10.4
Incandescent	0	13	50	37	0	0	10.3	10.0
LED	18	30	41	11	0	0	5.6	5.6
Liquid crystal	8	23	38	31	0	0	8.5	8.3
MICROPROCESSOR ICs								
8-bit	9	48	14	19	10	0	7.6	6.9
16-bit	0	41	29	18	12	0	9.1	7.0
FUNCTION PACKAGES								
Amplifier	0	25	38	37	0	0	9.5	7.3
Converter, analog to digital	0	25	50	25	0	0	8.5	8.3
Converter, digital to analog	0	25	42	33	0	0	9.2	10.1
LINE FILTERS	0	53	12	29	0	6	8.5	7.2
CAPACITORS								
Ceramic	26	19	37	18	0	0	6.3	5.5
Ceramic monolithic	25	29	25	21	0	0	5.9	5.8
Ceramic disc	29	8	46	17	0	0	6.5	5.5
Film	17	22	44	17	0	0	6.7	4.6
Electrolytic	24	32	28	12	4	0	5.8	6.7
Tantalum	10	30	41	15	4	0	7.2	6.1
INDUCTORS	10	40	25	25	0	0	6.8	8.1

Source: *Electronics Purchasing* magazine's survey of buyers

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A CAHNERS PUBLICATION
NOVEMBER 15, 1986

Electronic Business

Managing Technology: Unix moves from myth to reality

Disk drives: More memory for workstation vendors

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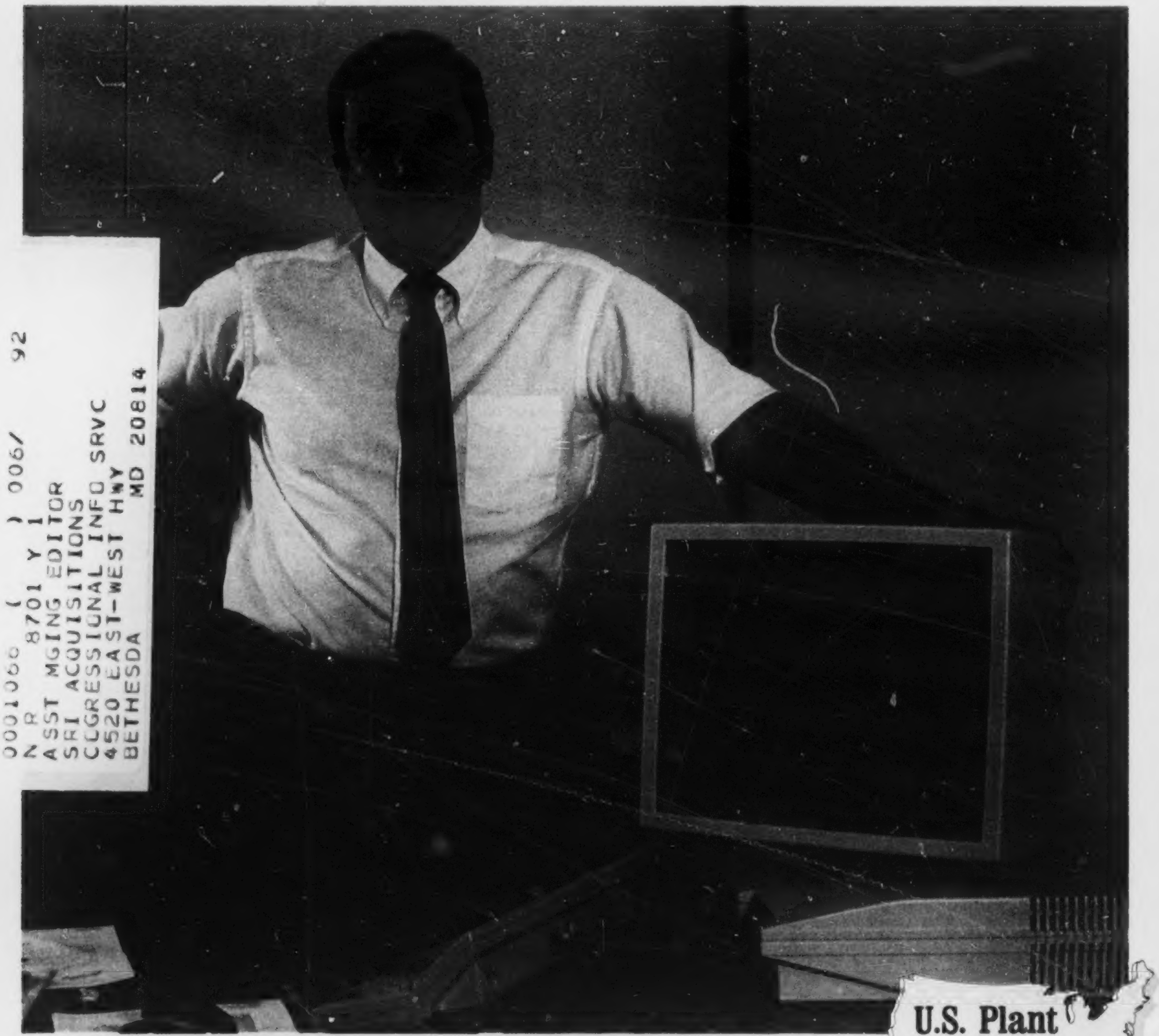

Intergraph's Meadlock tackles CAE with a Clipper engine

U.S. Plant Site Directory

Electronic Business

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NOVEMBER 15, 1986

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Cover photo/Bernd Billmayer

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BPA ABP

Fourth quarter's new products are next year's hopes

PCs based on Intel's 80386 microprocessors are the industry's bet for growing production in 1987

The industrial production of computers and office equipment (SIC 357) in the United States continues to underperform the country's total industrial production. While the latter has been up slightly every quarter in 1986 with respect to last year, and is expected to finish the year almost 1% ahead of 1985, industrial production for SIC 357 has declined so far every quarter this year. Cahners Economics forecasts for 1986 a drop of almost 4% with respect to 1985.

IBM's signals confirm Cahners forecasts. Its domestic sales, consisting mostly of equipment produced in the United States, have been faltering throughout 1986. Moreover, even foreign sales, the engine that propelled most of IBM's growth this year, lost steam in the third quarter. Even with the help of a weaker dollar, IBM's third quarter revenue of $11.9 billion was ahead of last year's by only $200 million. Had the dollar been at the level it was last year, revenue would have been $1 billion smaller. The company's management does not expect any better news in the fourth quarter. On the other hand, Digital Equipment Corp., Big Blue's smaller but very successful rival, continues to increase sales by more than 10% with respect to 1985. For the four quarters that ended last June, Digital's sales grew almost 14%.

According to the same forecast, we must wait until next year for SIC 357 to mend its ways and go back, with a 7% increase, to its historical outperforming of the economy. This growth will be almost double the one Cahners expects for the whole U.S. industrial production.

Computer manufacturers plan to partake of that increase. The last quarter of this year is bringing a flurry of new product activity, from Apple Computer Inc. to Wang Laboratories Inc. If, as their makers hope, the new products attract demand, U.S. production will benefit because a good chunk of the new machines will be manufactured in this country.

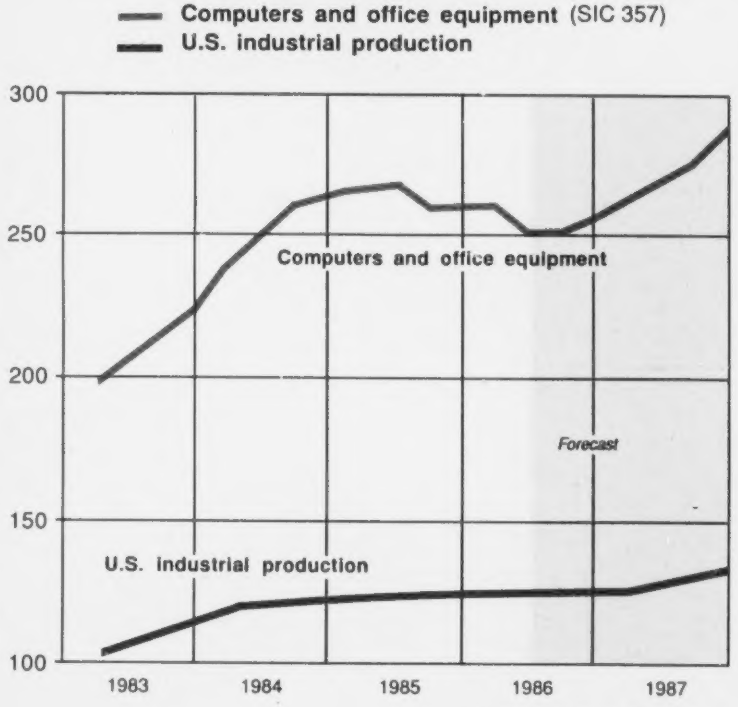
COMPAQ Computer Corp. led the way in that activity by introducing at the end of the third quarter the first personal computer that uses Intel Corp.'s new 32-bit microprocessor, the 80386. A host of companies, some established, some new, are readying similar machines for introduction in this quarter.

Big Blue itself is not expected to join the "386" fray until next year. By then, instead of using the Intel microprocessor, it may instead use custom chips which incorporate the 386 architecture. A new agreement with Intel gives IBM the means to do so. Moreover, a recent U.S. Supreme Court ruling in favor of Intel, which protects the copyright of a chip's microcode, gives IBM the means to fight would-be competitors who duplicate its computers by cloning its custom chips. In the meantime, IBM has aimed its new products at Digital, rather than at makers of PC clones. It introduced a medium size computer that can act as front end to, and is completely compatible with, its mainframe series 370. This is a U.S. product which probably will be successful and can, therefore, improve the chances for the computer industry in this country to match Cahners' forecast.

ALBERTO SOCOLOVSKY

Computers and office equipment

Industrial production indexes, 1977 = 100



Historical data: Federal Reserve Board
Forecast: Cahners Economics

Electronic components and accessories
Producer prices for electronic components rose 1.4% between October 1985 and March 1986, but then leveled off toward midyear. During the second quarter, a sluggish economy, when economic growth slowed to a crawl, marked a cutoff of end-user inventory accumulation which had fueled component market growth early in the year. Price levels inched up just 0.5% compared with the first quarter, the smallest gain since this industry's recovery began. Prices are expected to rise just 1.6% this year, down from a 2.4% rise last year. Orders will pick up again in 1987 and 1988, causing price pressures to build and resulting in annual gains of 2.8% and 3.6%, respectively.

Linear ICs
Producer prices for linear integrated circuits fell 1.2% in the second quarter from the prior quarter, or at a 4.7% annualized rate of decline. However, early reports for the third quarter point to more stable or perhaps slightly rising prices. This will help to reduce the annual decrease to approximately 4.2% from 6.3% last year. Prices should begin to experience a slight upward pressure by early 1987 but will be restrained by excess industry manufacturing capacity and continued low inflation rates in the United States. A modest 3.9% increase in prices is expected next year.

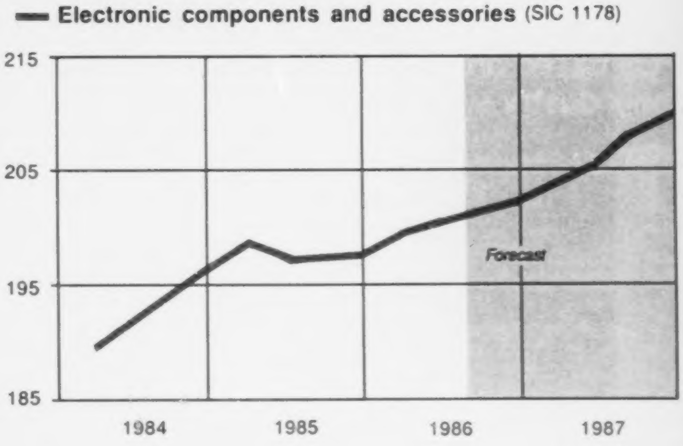
Digital bipolar ICs
Second-quarter prices for digital bipolar IC's jumped 4.1%, the sharpest increase since summer 1983 when the industry was in the midst of a strong expansion. The latest advance resulted from a rapid rise in customer order rates during late 1985 and early 1986. A summertime slump in the semiconductor market should temporarily alleviate this upward pressure, causing prices to slip below the second quarter's rate. Prices are now expected to average about 3.7% higher this year than they did in 1985. If customer markets show the expected improvement in 1987 and 1988, then prices will begin to climb again soon. We anticipate a rise of nearly 8% next year and a 6.2% increase during the following year.

Digital MOS ICs
Producer prices of digital MOS IC's increased 4.7% in this year's second quarter, reaching their highest levels since mid-1985. However, an interruption in the semiconductor industry recovery starting this spring and stretching into the fall is likely to bring more stable price trends in the second half of the year. Prices should begin to move up again once demand begins to rebound in early 1987. After tumbling 18% in 1985, prices are expected to decrease by a margin of 9.7% this year. This should be followed by increases of 6.2% and 2.3% in 1987 and 1988.

Producer price indexes

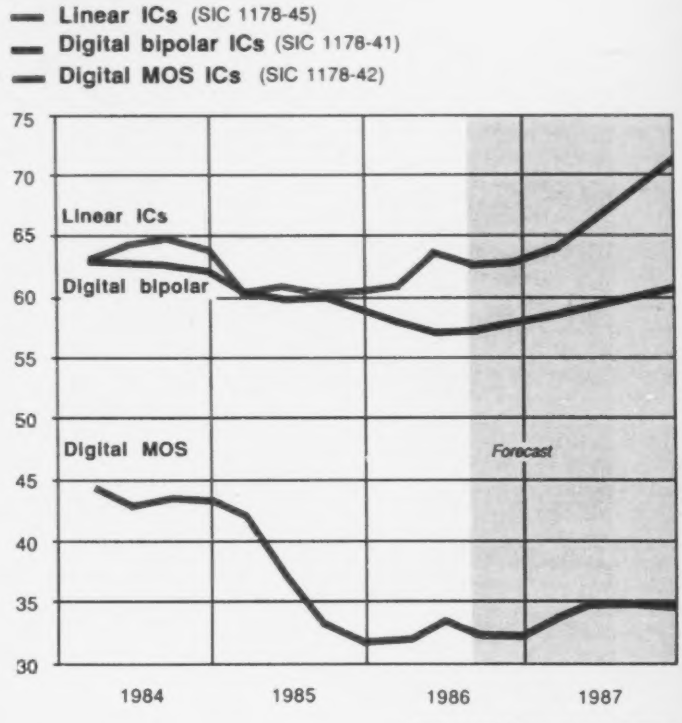
Electronic components

December 1967 = 100, quarterly averages



Integrated circuits

December 1974 = 100, quarterly averages



Historical data: Bureau of Labor Statistics
Forecast: Cahners Economics

Electrical machinery
The rate of capacity utilization in the electrical and electronic machinery industries continued to slow in the second quarter, dipping to an average 71.2% from 71.6% in the first quarter. Two factors placed downward pressure on the factory operating rate during the latest quarter: 1) lingering weakness in electronic component production, and 2) strike-related declines in the communication equipment market in June. Production resumed in the latter area during July, a fact which could push the rate back toward 72% in the second half of the year. Stronger improvements are expected to follow in 1987 and 1988, with the operating rate reaching 75% by the end of next year and about 80% by year-end 1988.

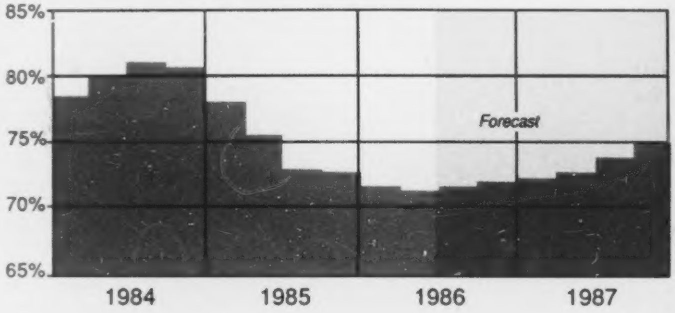
Instruments
Instrument manufacturers operated at 80.5% of available capacity in the second quarter, down sharply from a rate of 82% in the first three months of the year. The loss reflected a 0.6% real quarterly decrease in production which was concentrated in a few large segments of the industry including watches, clocks and photographic equipment. A pick-up in U.S. business investment and quickening of consumer spending should help to reverse this downtrend by mid-1987. The operating rate is expected to finish 1986 at about 77%, dip below that level early next year, return to it by the end of 1987, and then show a gradual increase to about 81% over the course of 1988.

Aerospace
In the second quarter, manufacturers of aerospace equipment operated at 87.2% of capacity, a slight increase over the first quarter's 86.5% rate. Although defense spending has begun to slow under the weight of budget cutbacks, backlogs remain sufficiently high to sustain a strong rate of production in the aerospace industry for at least another year. Plant utilization is expected to increase steadily over the next several months, reaching a peak rate of close to 90% during the first half of 1987. Manufacturers should begin to scale back their production levels after that, cutting plant use to a level of about 82% by the end of 1988.

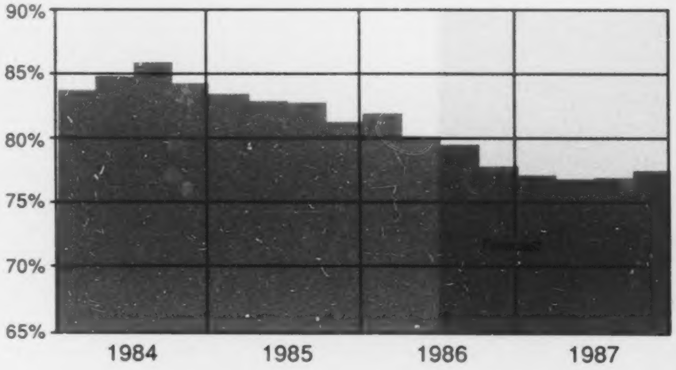
Plant utilization

Average percentage of capacity utilized per quarter

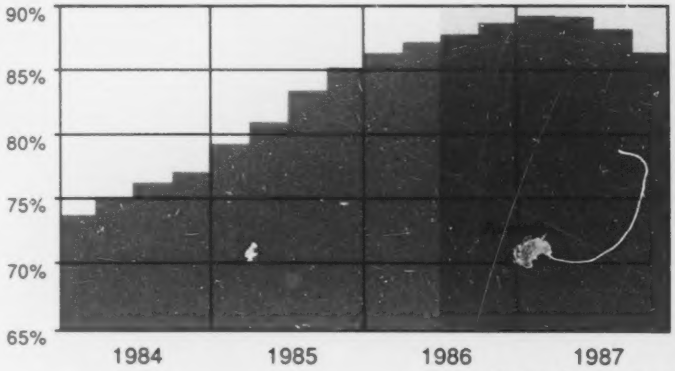
Electrical machinery (SIC 36)



Instruments (SIC 38)



Aerospace (SIC 37)



Historical data: Federal Reserve Board
Forecast: Cahners Economics

Automation: IBM puts MAP on the map in Endicott, N.Y.

In a pilot project, IBM is wiring one of its oldest plants in a key test of MAP on the factory floor

A portion of the production line for printed circuit boards at IBM's oldest manufacturing plant is in the process of becoming its most modern. In a pilot program at its Endicott, N.Y. facility, IBM is utilizing Manufacturing Automation Protocol (MAP) to tie together equipment from several leading automation vendors. The experiment could prove to be a key test of MAP as the communications link for factory automation.

For that reason, the results of the IBM pilot project will be closely followed, not only by printed circuit board makers, but also by companies who supply MAP-compatible equipment. With IBM's blessing, the market for MAP local area networks (LANs) — utilizing both broadband and carrierband technology — could climb to $369 million by 1990, about 78% of the total projected market for industrial LANs, according to Venture Development Corp., a market research firm in Natick, Mass. And in the words of one veteran automation analyst, "If IBM can't make this work, who can?"

The pilot is particularly important because General Motors Corp. (GM), the prime mover behind establishing MAP as a standard, has slowed its capital spending in factory automation, raising questions about the viability of MAP. Some analysts also raise questions about IBM's commitment to the technology.

Even if IBM does have questions, though, about the long-term viability of MAP, it is moving forward with the Endicott pilot. The project, which will be completed early next year, will attempt to link various stand-alone process monitoring systems so that an engineer, sitting at a personal computer (PC) in a separate building, can access information — either from a host mainframe or from a smaller computer, such as an IBM Series/1 minicomputer, on the factory floor.

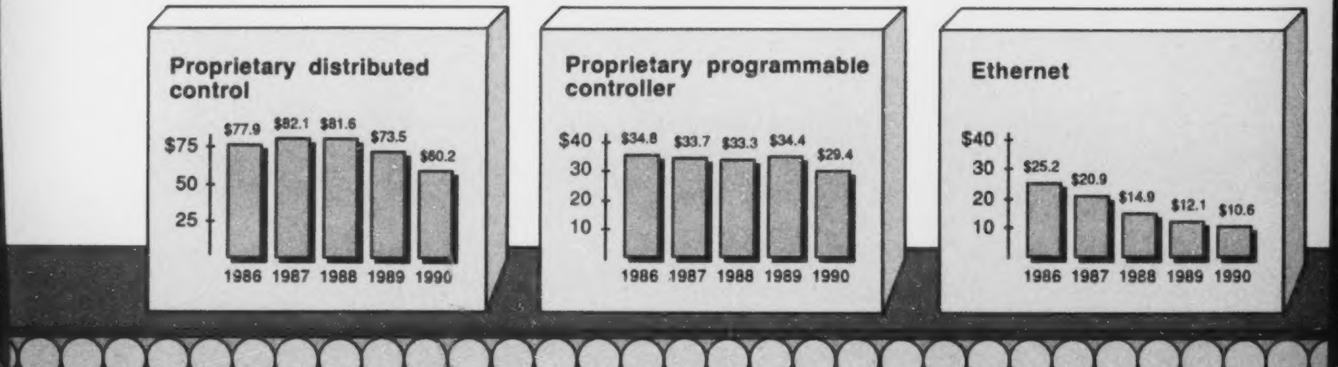
Presently, engineers must walk the factory floor at the Endicott facility — which manufactures advanced printed circuit boards for IBM's 3090 mainframe series — to obtain data on the manufacturing process. But if the MAP pilot works, the engineers will have access to all systems from a single PC, enabling them to more quickly monitor conditions on the line. Theoretically, this will translate into productivity gains down the road, since the company is implementing the pilot with an eye toward providing a means to incorporate additional MAP technology in future IBM products.

"This is an investment in the future," says Richard Sheftic, IBM's project leader for the pilot. "It can't be justified on an ROI [return on investment] sheet. The benefits are knowledge and experience." The Endicott plant, though, is primarily about IBM as a user of MAP technology and not a lab for the development of IBM's MAP products, Sheftic says. The pilot was not designed as an experiment, but as a working model. In fact, the production line has continued to operate at full capacity while the project team redesigns and rebuilds the line for MAP. When the conversion takes place, the line will shut down for only a few hours, Sheftic says. "We did not want to disturb the line in any way," he says.

A place for everything

The project encompasses four areas of advanced printed circuit board

Shipments of industrial local area networks segmented by network type ($ millions)



IBM's SHEFTIC: The Endicott pilot project is an investment in the future

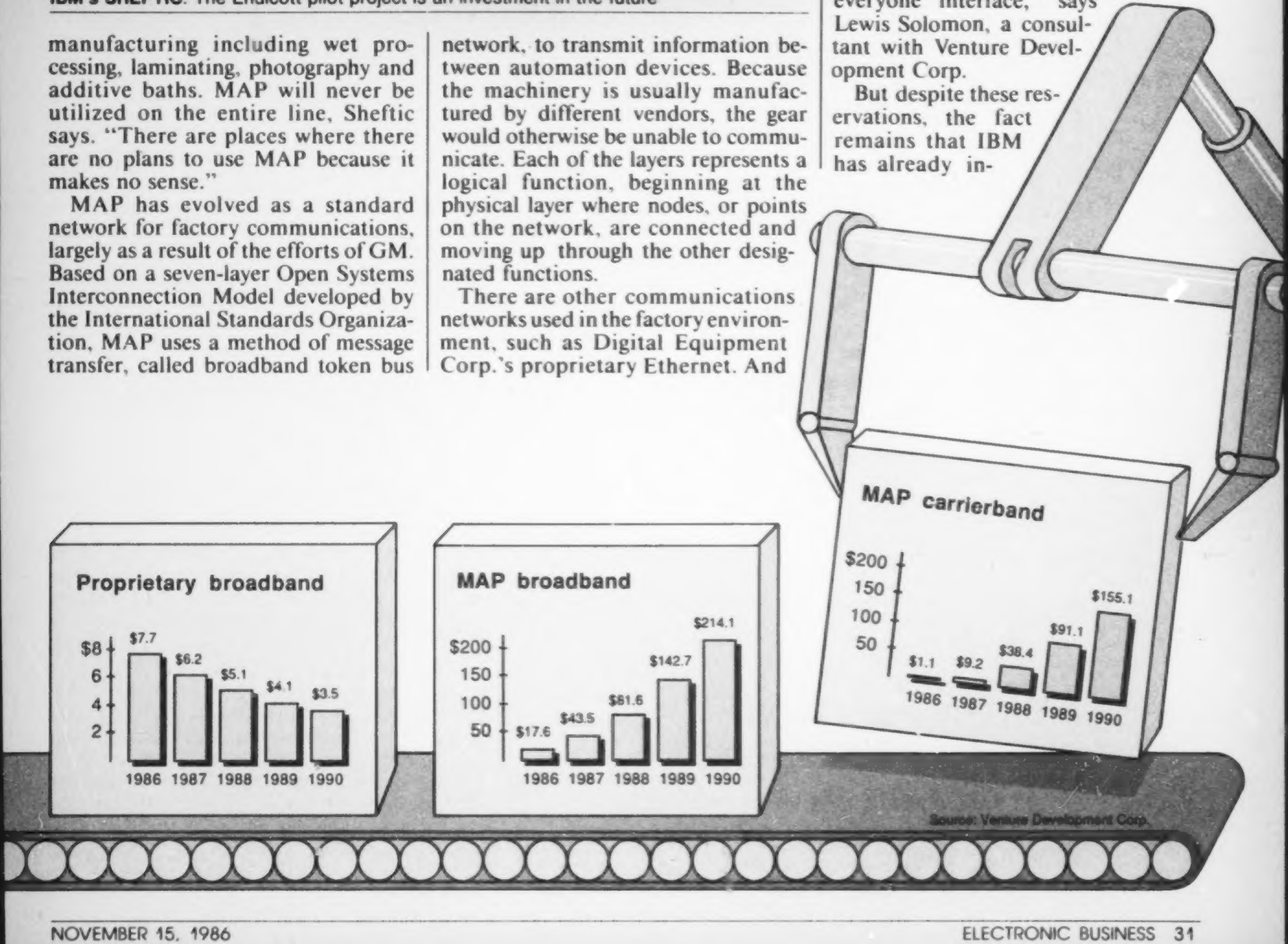
manufacturing including wet processing, laminating, photography and additive baths. MAP will never be utilized on the entire line, Sheftic says. "There are places where there are no plans to use MAP because it makes no sense."

MAP has evolved as a standard network for factory communications, largely as a result of the efforts of GM. Based on a seven-layer Open Systems Interconnection Model developed by the International Standards Organization, MAP uses a method of message transfer, called broadband token bus network, to transmit information between automation devices. Because the machinery is usually manufactured by different vendors, the gear would otherwise be unable to communicate. Each of the layers represents a logical function, beginning at the physical layer where nodes, or points on the network, are connected and moving up through the other designated functions.

There are other communications networks used in the factory environment, such as Digital Equipment Corp.'s proprietary Ethernet. And while MAP will not be the sole choice for factory networks, it seems clear the standard will be the most popular. But as was the case with robots, the use of MAP has developed slowly and taken more time to implement than some expected. It is that early experience with implementation which may prove to be a competitive advantage to IBM and other companies, such as Deere & Co., Eastman Kodak Co. and Boeing Co., which are also installing MAP pilots.

The Endicott pilot notwithstanding, though, some analysts question just how deep IBM's commitment to MAP really is. "They support it," says Robert Harbage, a senior consultant with the A.D. Little Co. in Cambridge, Mass. "But they're not moving as fast on it as some other people." There are also serious questions about whether MAP, which is above all else a standard aimed to permit the interconnection of equipment from all vendors, is in IBM's best interests. "I'm not sure IBM wants to be moving ahead to let everyone interface," says Lewis Solomon, a consultant with Venture Development Corp.

But despite these reservations, the fact remains that IBM has already in-



Source: Venture Development Corp.

stalled the cable and made the physical connections in the Endicott plant, and is now involved in the tricky task of writing software — software it reportedly will later try to sell as a package with the Series/1. Marcia Brooks, a senior analyst with International Data Corp. in Framingham, Mass., thinks IBM may be using the Endicott project to promote the Series/1, a machine which she says may not be able to compete in the factory environment with the PC as a workcell controller.

For all its significance, the IBM MAP pilot is still limited in scope. Ideally, Sheftic says, a company would build a new line utilizing MAP. But he and IBM hedged their bets.

Too many unknowns

"There are so many unknowns about MAP, we tried to limit the number of variables," he says. "We're trying to move incrementally." For that reason, none of the equipment purchased from other vendors for the pilot will be tied directly to the broadband cable. That gear includes programmable logic controllers purchased from Rockwell International's Allen-Bradley Co. subsidiary and Texas Instruments Inc., and a data acquisition unit from Hewlett-Packard Co. This equipment will be meshed with an IBM 370 host computer and IBM Series/1 minicomputers on the shop floor which provide monitoring system data. Interfaces supplied by Concord Communications Inc. connect the minicomputers to the MAP broadband cable which is the information highway.

The purchase of this equipment from outside vendors, some observers say, is an indication of how serious IBM is about the Endicott project as well as a recognition of some of the company's own shortcomings in automating manufacturing plants. "They realize they can't do everything on the factory floor," says Solomon. "They're going to have the first insight, even before GM, of how to make it work, and how hard it is."

"We recognize that we must purchase equipment from other vendors," says Sheftic. "It's going to be a mixed-vendor environment, like GM's, out into the later '80's and early '90's." A.D. Little's Harbage, though, takes a different view of IBM's involvement with MAP. He sees the Endicott project more as an instance of IBM's caution than its daring. "They could be penalized for not being MAP-compatible," he says, and so they are going ahead with utilizing the communications protocol.

From his perspective on the shop floor, Endicott project manager Sheftic takes a pragmatic view of the MAP technology. "From a user's point of view, MAP is a tool," he says.

The pilot project, Sheftic admits, will be fairly primitive in that MAP has progressed since IBM committed itself to the project one year ago at the Autofact Show in Detroit. "You've got to remember," he says, "that this is an early MAP project." And there is still no telling exactly in what form the protocol will emerge.

Indeed, vendors frequently complain that the standard changes too rapidly to permit product development cycles. But no matter how primitive the system, and whatever the reasons behind it, the fact is that IBM will likely have one of the first automated plants utilizing MAP when others are still just talking about it.

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Gramm-Rudman casts a pall over federal computer sales

U.S. computer makers did fine in fiscal 1986, but the prospects for 1987 are uncertain, due to deficit reduction

If the capital investment slowdown in the private sector was not bad enough, computer vendors now have to put up with another headache: Gramm-Rudman-Hollings. The deficit reduction act is expected to put a damper on federal computer sales in the coming year.

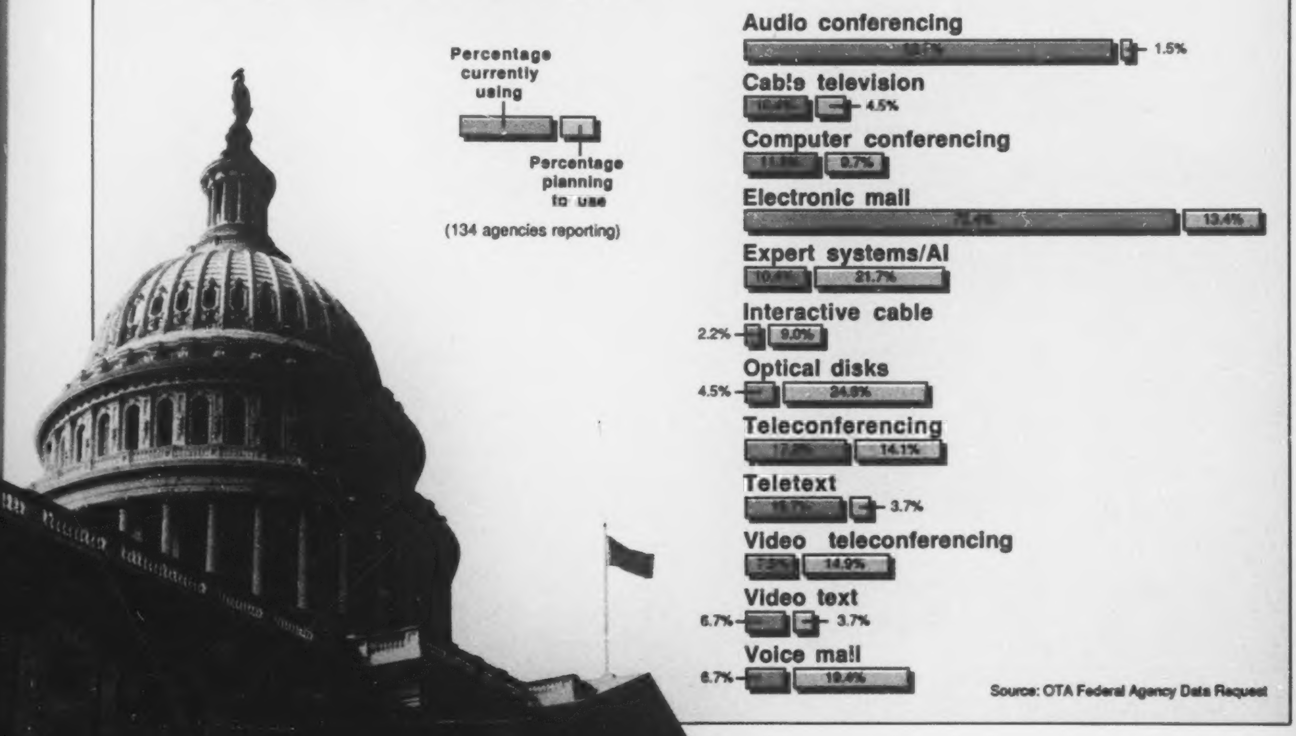
Harold "Hal" Julsen, vice president of marketing for Control Data Corp.'s Government Systems Group, for example, says CDC's sales level is "about the same for 1985 and 1986. But the apprehension over Gramm-Rudman has put lots of confusion into the market. We've seen the stretching out of programs, the canceling of them and lots more competition."

The impending impact of Gramm-Rudman looks particularly grim because, on the whole, computer makers did not make out too badly in the federal fiscal year that ended Sept. 31. Once the final figures for fiscal 1986 are tallied, analysts expect purchases of nonmilitarized general-purpose computers, peripherals and software by both the military and civilian federal agencies to have risen 15% over last year's approximately $14 billion level. Also, the Office of Management and Budget estimates that federal information-technology spending will reach $15.2 billion in fiscal 1986, a 4% increase over the previous year's figure.

The top five federal purchasers remain the same as last year, too: the Air Force, Army, Navy, the National Aeronautics and Space Administration (NASA) and the Department of Energy. Likewise, the type of products they are buying has not changed much. Mainframes and standalone microcomputers remained hot. (A recent Office of Technology study noted that the number of mainframes installed in federal agencies more than doubled between 1980 and 1985, to 27,000. During the same period, the number of mainframe terminals more than quadrupled to 170,000, while the number of microcomputers climbed from a few thousand to 100,000.)

Other big sellers last year were local area networks, the Unix operating system and Ada, the military's standard programming language. Supercomputers and database machines (computers optimized to run large-scale database management programs) increasingly seem to be making inroads into federal agencies as well. High-end equipment is doing well because agencies are being forced to get more bang for their data-processing buck as a direct result of Gramm-Rudman, according to Lem Wiggins, federal marketing manager of the Atlanta-based federal division of Teradata Corp., a leading manufacturer of database ma-

Federal agencies' current and future plans for electronic technologies



Source: OTA Federal Agency Data Request

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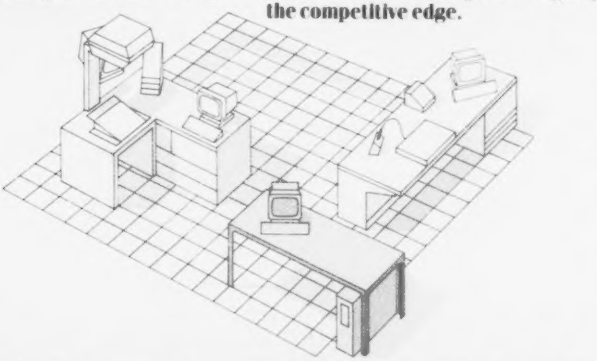

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chines. "Government customers are embracing database machines faster than the commercial market," Wiggins says.

Control Data's Government Systems Group in Minneapolis also reports increased interest in higher power hardware. Government Systems concentrates on selling militarized products, but also offers general-purpose systems and services to the Department of Defense (DoD), NASA and other defense-related agencies. (CDC's commercial groups are charged with selling into most of the other agencies.) Accordingly, the Government Systems Group is investigating RISC (reduced instruction set computer) and fault-tolerant architecture, as well as "smaller, air-cooled, lightweight, powerful computers" in direct response to the federal government's demands, says group vice president Julsen. Government interest in its Cyber mainframe computers remains high, he says, and should be boosted even higher when CDC comes out with its Ada compiler for the systems in early 1987. And the ETA supercomputer, manufactured by CDC spinoff ETA Systems Inc., should be of great interest to NASA and the DoD after it debuts next year, Julsen predicts.

Supercomputers and database machines are making inroads

Digitial Equipment Corp.'s Government Systems Group also sees increased demand for its MicroVAX and cluster product lines. Purchases of the DECnet local area network and the company's Ada compiler also are going great guns, according to Frank Posey, manager of Government Systems. Ada, software designed specificially for military applications, "especially is picking up steam," Posey says. "It's our sixth fastest selling software product," he says.

Echoing the fears of other managers of federal systems divisions, Posey says he has not seen any fallout from the Gramm-Rudman bill. "It's a tougher competitive environment now," he concedes. "Not all of it's due to Gramm-Rudman. But we keep expecting it [Gramm-Rudman] to hit any time now."

MARY JO FOLEY

Foley is a Washington, D.C.-based business writer

High-stakes poker in Huntsville, Ala.

Jim Meadlock, founder and president of Intergraph, is gambling on a new chip, a new workstation and a new strategy

By David Card

In the foothills of the Great Smokies there is a little high-tech hamlet called Huntsville. Spawned by Werner von Braun's rocket crew, working out of the National Aeronautics and Space Administration's (NASA) Marshall Space Flight Center, this Alabama city is now the home of several major electronics companies, including contract manufacturer SCI Systems Inc. But the standout in town is Intergraph Corp., which — with its 44% five-year growth rate — is now the second largest supplier in the computer-aided design and manufacturing (CAD/CAM) market behind IBM.

But although publicly traded Intergraph had $526 million in sales last year, and its salesforce seems to favor pinstriped suits, just like the folks from IBM, the firm still has the feel of a small company. Intergraph execs entertain at the company's favorite restaurant, the Greenbrier Bar-B-Que, which stands in the middle of a cotton field. The house specialty is a dinner combo of fried catfish, pork barbecue and hush puppies. The restaurant still serves Dr Pepper.

Ex-IBM engineer James Meadlock, Intergraph's 52-year-old president and founder, who once designed flight computers for NASA's Saturn V and Titan II rockets, is a workaholic who runs a tight ship. He abandoned his house in a nearby town three years ago to build a new home less than a hundred yards from Intergraph's headquarters.

But today, because the company is too big to be run by one person, Meadlock recently decentralized the organization to give more authority to divisional leaders. "We'll be a billion-dollar company in two or three years, unless we really screw up," predicts John Gridley, vice president for finance.

But that, of course, is the central question at Intergraph today: Will the company screw up?

Until now, Meadlock and Intergraph have won rave reviews from Wall Street and industry watchers. "Meadlock is one of the few living geniuses around in this business," says Charles Foundyller, president of Daratech Inc., a Cambridge, Mass., CAD/CAM market-watching firm. "If you look at Intergraph, historically they've been ahead of the industry in adopting evolving standards," adds Peter Heymann of Drexel Burnham Lambert Inc.

In the early CAD/CAM years, when competitors, such as Applicon Inc. (now part of Schlumberger Ltd.) and Computervision Corp., were offering automated design systems based on proprietary hardware, Intergraph sold systems based on computers from Digital Equipment Corp. — the No. 2 computer player overall (yet No. 1 in the hearts of engineers). Then, in the early 1980s, Intergraph wrote additional software to run on DEC's new VAX family of high speed 32-bit superminicomputers. Not coinciden-

AT A GLANCE

Intergraph Corp.
Huntsville, Ala.

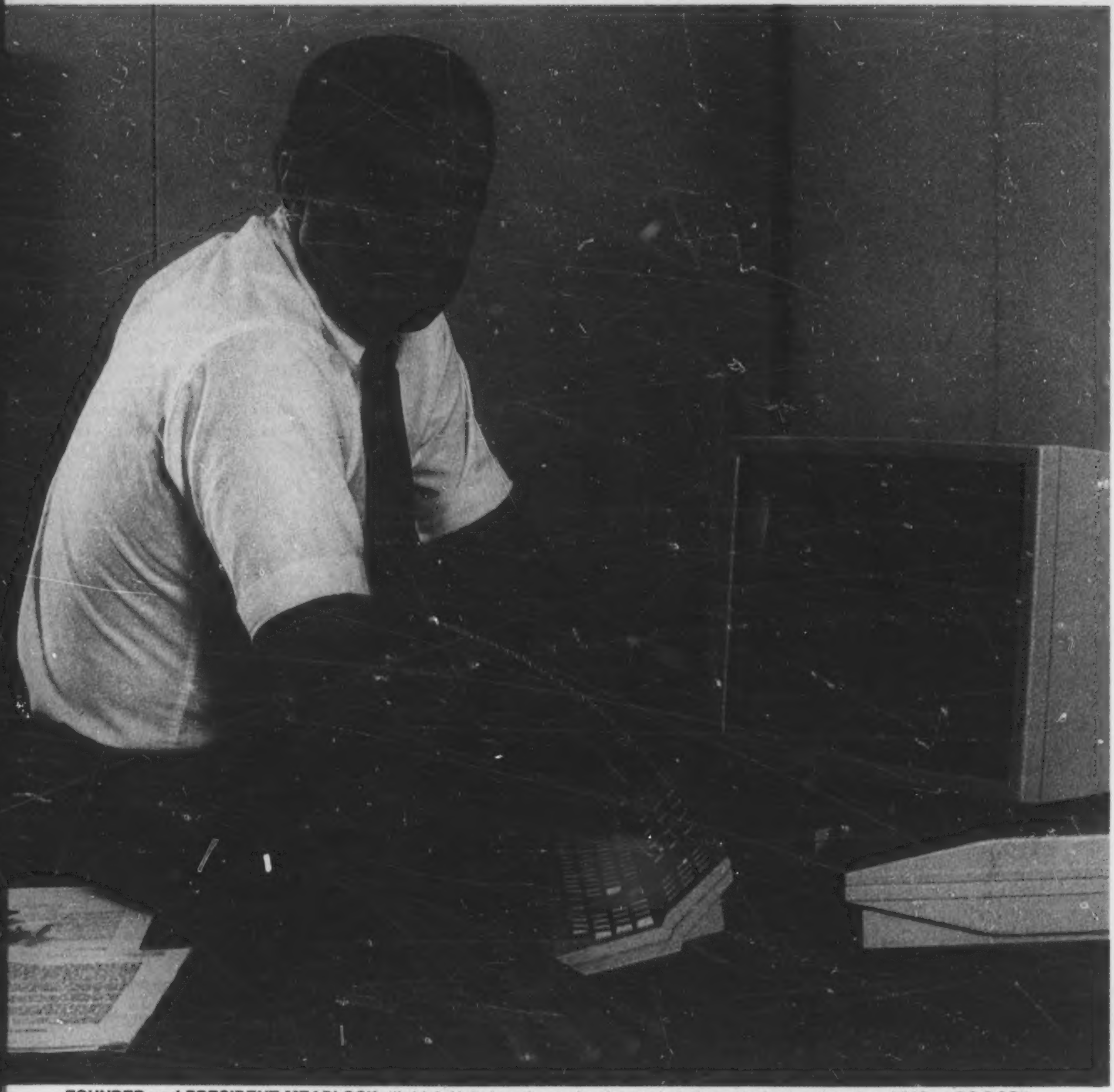
	FISCAL YEAR COMPARISON		
	1984	**1985**	**Change**
Sales ($ thousands)	$403,762	$526,405	+30.4%
Net income ($ thousands)	$62,936	$67,779	+7.7%
Net income/sales	15.6%	12.9%	–
Cost of sales/sales	47.3%	50.6%	–
R&D/sales	9.2%	9.6%	–
Marketing/sales	9.3%	10.7%	–
Capital expenditures/sales	5.6%	7.8%	–
Number of employees	3,700	5,100	+37.8%
Sales per employee	$109,125	$103,217	-5.4%
Net income per employee	$17,010	$13,290	+21.9%
Current ratio	2.63	4.37	–
Debt/equity ratio	0.04	0.03	–

Fiscal year ending December 31,

	MOST RECENT NINE MONTHS		
	1985	**1986**	**Change**
Sales ($ thousands)	$370,935	$448,354	+20.9%
Net income ($ thousands)	$49,093	$50,842	+3.6%

Nine months ending September 30,

Source: Dow Jones News/Retrieval



FOUNDER and PRESIDENT MEADLOCK: "I think Unix is going to be the workstation standard, rather than VMS or PC DOS"

Bernd Bellmeyer

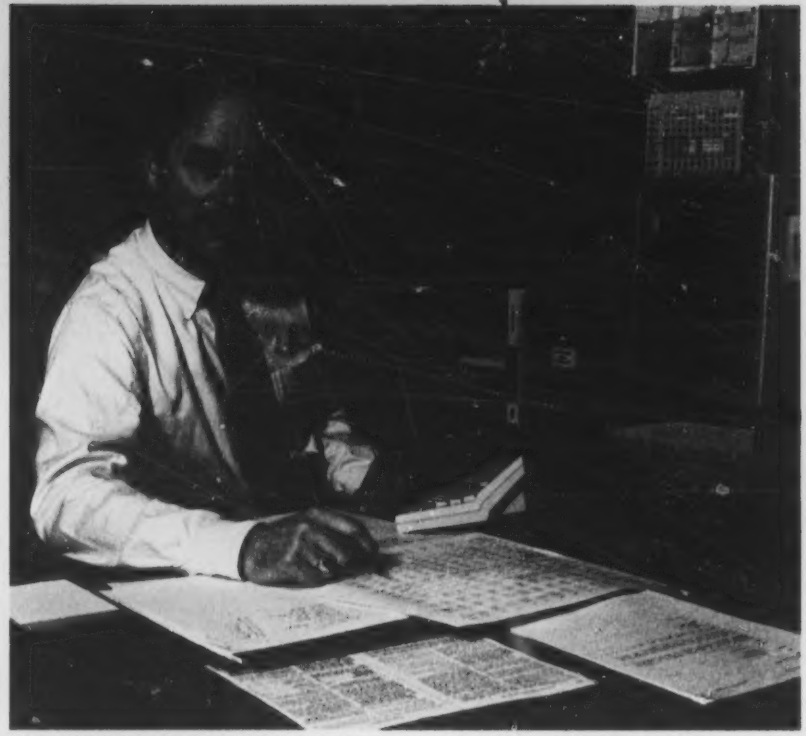
tally, Intergraph's sales took off.

In hindsight Meadlock's decision to follow DEC makes clear sense. The VAX is now an industry standard. But at the time it looked like a bit of a gamble. Now, Meadlock seems to be gambling again. He is moving Intergraph into a new market — computer-aided engineering (CAE) — and he is doing it on a new hardware engine. Intergraph, DEC's largest original equipment manufacturer (OEM), will continue to remain a DEC reseller, but will add to its hardware lineup its homemade Unix workstation, the Interpro 32. Both moves are bold, maybe too bold.

Meadlock says that the decision to move into CAE systems for printed circuit board (PCB) and integrated circuit design, and the decision to build its own computers are two separate issues at Intergraph. Coincidentally, CAE will also be the first test case for the Interpro workstation. So far, the company has only sold 1,000 workstations. But if the new Unix-based Interpro is a hit, it could prove that the Unix operating system — the software that controls the internal functions of a computer — can overcome the appeal of hardware labeled DEC or IBM. Other CAD/CAM companies, notably Computervision, are also migrating to Unix.

But critics, such as Frank Costa, a general manager at CAE rival Mentor Graphics Corp. calls Meadlock's belief that Unix is more important than the hardware it runs a "pipe dream." Meadlock, however, is not deterred. "I think Unix is going to be the workstation standard, rather than VMS [DEC's operating system] or PC DOS [IBM's]." Indeed, both DEC and IBM grudgingly support their own versions of Unix. But, if Meadlock is wrong, then he risks losing his momentum in CAD/CAM — maybe forever.

On top of this, the market that he picked to try out the new Interpro



VICE PRESIDENT for FINANCE GRIDLEY: "We'll be a billion-dollar company in two or three years, unless we really screw up"

Bernd Balmeyer

presents plenty of problems. Electronic design, like other CAD/CAM markets, has slowed in recent months, one reason why Intergraph posted only modest growth in sales and earnings for the past two quarters. Moreover, although the electronic design market, totaling $800 million in 1985, is the fastest growing segment of the $3.6-billion CAD/CAM market, it is still an overcrowded field. CAE is just packed with aggressive start-ups such as Daisy Systems Corp. and Mentor Graphics, as well as bigger companies — Hewlett-Packard Co., IBM and Tektronix Inc. Although Meadlock is covering himself by keeping the bulk of Intergraph's offerings on various VAXs, the Interpro will be going head-to-head with DEC's own workstation, the VAXstation II GPX.

Also, this year in another gamble, Meadlock has souped up the Interpro to be more competitive with CAE workstations like the VAXstation by redesigning his machine's heart. The first version of the Interpro, introduced two years ago, was based on the National Semiconductor Corp. 32032 microprocessor, but sales were disappointing. Intergraph says that a lack of software held back the Interpro. Nevertheless, this year, Meadlock has switched microprocessors in midstream, moving from the National chip to the spanking new Clipper from Fairchild Semiconductor Corp. It remains to be seen, though, whether the Fairchild's architecture will have any greater impact than National's.

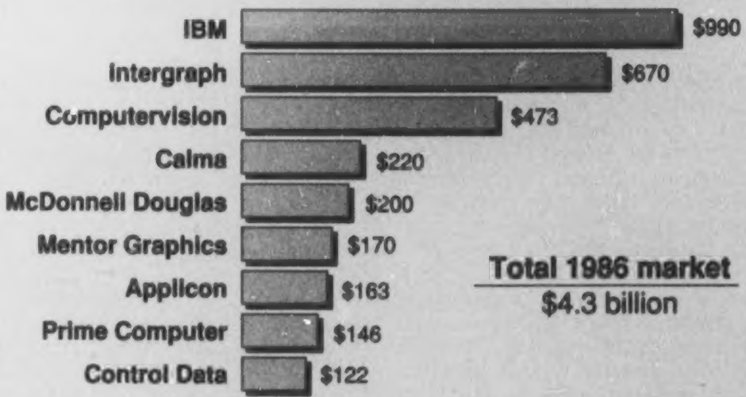
Meanwhile, there are some indications that Intergraph may face some tough competition in the year ahead. Xerox Corp., for example, helped get Intergraph started in the mechanical CAD/CAM business back in 1982. The Rochester, N.Y., copier division reportedly owns some $25 million worth of Intergraph equipment. But Xerox — Intergraph's largest mechanical customer, notes Meadlock — refuses to talk about future plans. Xerox execs say that the company is in the process of bringing on line its own CAD systems, courtesy of Xerox's Engineering Information Systems division in Santa Clara, Calif. The CAD/CAM market proved too attractive to pass up.

At Boeing Electronics Co., another Intergraph customer, there also may be problems. Boeing has two Intergraph VAX-based systems with 16 terminals for circuit board and hybrid design, according to Ronald Lemon, electronic CAD operations manager in Renton, Wash. Lemon says that the Intergraph tools are perfect for designing boards with surface-mounted components on them, something Boeing's older line of Computervision equipment could not handle. Service from the company, he says, is excellent. But, because Boeing has a heavy investment in Mentor machines, the company does not envision Intergraph as a workstation supplier, Lemon says. Lemon also does not currently see any real demand in the electronic design market for Unix.

A similar situation also seems to be taking place at Ford Motor Co., another Intergraph customer. Much of Ford's mechanical CAD/CAM gear is a combination developed jointly by Ford and the team of Prime Computer Inc. and Lundy Electronics & Systems Inc., according to Ford's executive engineer for engineering and administra-

Intergraph: No. 2 in the CAE, CAD/CAM market

Forecasted 1986 worldwide sales ($ millions)



Source: Daratech Inc.

tive services, Basil Hooten. The Dearborn, Mich., auto maker also uses systems from Computervision and Daisy.

However, a Dearborn group is evaluating Intergraph equipment for PCB design, and a team, out of Ford Microelectronics Inc. in Colorado Springs, Colo., is interested in Intergraph's tools for designing hybrid circuits. Hooten says that Ford's current PCB software — from Harris Corp.'s Scientific Calculations Inc. subsidiary — does not quite "measure up to Intergraph." Likewise, Intergraph's hybrid-design package tested against a number of competitors, including Hewlett-Packard, and came out "the clear winner every time," according to Hooten. So far, so good.

The problems arise, not from Intergraph's performance but, from its choice of hardware. Intergraph's MicroVAX-based systems go over fine with Ford's engineers, but the auto maker's "corporate-computer gurus," Hooten says, have decided to standardize office automation (OA) on the IBM PC AT, and are leaning that way for engineering as well.

This month Ford should be finishing a 90-day study assisted by Arthur D. Little Inc. to decide if IBM will be the company standard. "The typical engineer in this company spends at least half his time in nontechnical work," Hooten says. "He needs an OA machine." The OA machine of choice is IBM's PC AT, "because there's so damned much third-party software running on it." So far Intergraph has been reluctant to do anything for the AT, Hooten says. "Who knows? Maybe we could twist their arm. We were hoping Arthur D. Little would convince them," he says,

So for the time being, Hooten says, he considers Intergraph a niche supplier. Even though Ford is keen on Unix and open networking — two traditional IBM weaknesses, according to Hooten — IBM apparently has won out in office automation. It looks like management had enough confidence in IBM promises for future products to go with the big guy.

The big bet

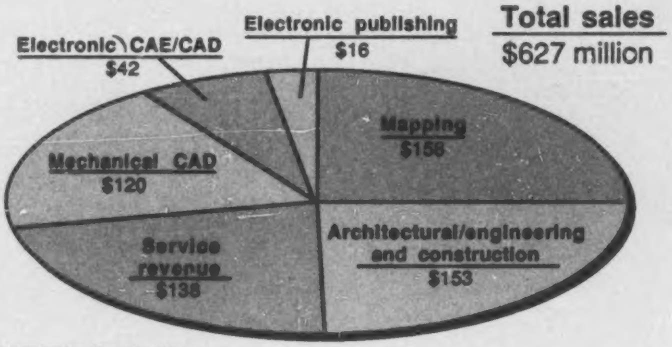
When Intergraph successfully moved into mechanical CAD/CAM four years ago, it broadened its customer list. Today, Intergraph's customers include BellSouth Corp. and Phillips Petroleum Co. for computerized mapping systems, auto makers Volkswagen Do Brasil S.A. and Porsche AG for mechanical CAD, ROLM Corp. and Allied Signal Co.'s Bendix for circuit board design, Ford Motor Co. for plant design and Rockwell International Corp. for computer-aided publishing. Ideally, the company would like sales to be evenly distributed across its four major segments — mapping, mechanical CAD, electronics and architectural/construction design.

But some critics claim that Intergraph could be jeopardizing its position in these segments if the company decides to move into computer manufacture. "I can't understand why one of our significant competitors is doing what we just moved out of," says a puzzled Bardwell Salmon, marketing vice president for number three CAD/CAM supplier Computervision (CV). What Computervision just moved from was a propriety computer. CV had been making its own computer since 1977 and leading the CAD/CAM market with it, mostly in mechanical drafting and circuit board layout. Then as IBM and DEC-based Intergraph took off in the early 1980s, CV's fortunes declined. Last year this incompatible hardware strategy caught up with CV, and the Bedford, Mass., company lost $80 million and laid off a third of its workforce.

Now CV is in the midst of rewriting its software, all 6.5 million lines of it, to run under the Unix operating

Intergraph wants to spread out its sales...

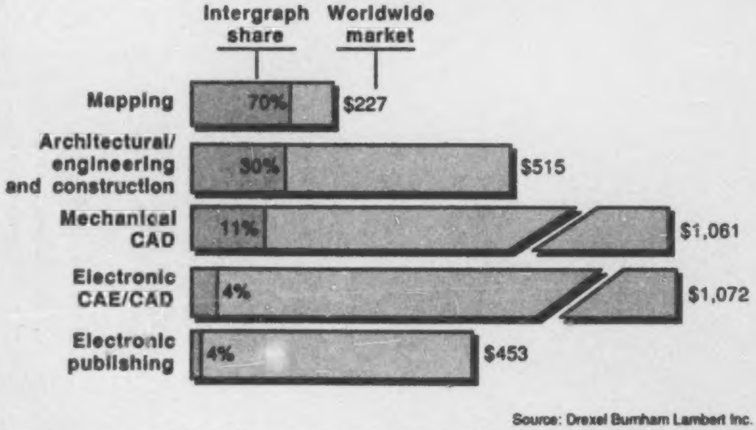
Forecast 1986 sales by market segment ($ millions)*



*For fiscal year ending December 31

...to increase its share in the larger markets.

Estimated 1986 sales by market segment



Source: Drexel Burnham Lambert Inc.

system. This task is 85% done, according to CV's new president, Robert Gable. The resulting system will run on a workstation by Sun Microsystems Inc. Why build your own computer? Gable now asks rhetorically. "You're in danger of bringing out your own hardware, only to have it obsoleted one month later by a DEC announcement."

George Meister, a senior vice president at Manufacturing Industry Systems Co. (MISCO), part of aerospace giant McDonnell Douglas Corp., agrees. Last year, his company, which sells CAD software for Data General Corp., DEC and IBM computers, beat out Intergraph in a contract bid at Eastman Kodak Co. Customers prefer name-brand computers to machines built in-house, he says.

Strained relations

One reason Meadlock decided to build his own workstation, rather than resell DEC's machines, may have something to do with its overall relationship with DEC. Tension between the two companies is almost inevitable, analysts say, as DEC, which once sold almost exclusively through the original equipment manufacturing (OEM) market, moves slowly toward end-user sales.

Meadlock admits as much. "As we get bigger, we compete more with them. DEC also is not as OEM-oriented as they were 10 years ago and that causes some strains. But I think we've both recognized the territory we're treading and we've adjusted to it," he says. Moreover, Meadlock believes while most engineers want workstations, they also need bigger machines for data storage. This is where DEC fits in. "I don't plan to *not* buy VAXs," he concludes.

Ironically, if DEC had been able to

Sailing away on the Fairchild Clipper

Building its own computer is not Intergraph's only controversial strategy. The way it went about it is raising some eyebrows, too.

Critics, for example, question Intergraph's choice of the Clipper microprocessor of Fairchild Semiconductor Corp. to power the Interpro 32C workstation, especially since the original Interpro was based on National Semiconductor Corp.'s 32032. Intergraph spent some $10 million to switch chips, estimates Shearson Lehman Brothers Inc. analyst James Stone.

Intergraph electronics marketing manager Harold Barbour contends that, since its introduction in September 1984, a lack of software — rather than any problems with the computer or its chip — has kept the Interpro's sales at a disappointing 1,000 units. The National-based Interpro has been selling as a terminal for VAX-based applications. Now, he says, all Intergraph's electronics computer-aided engineering (CAE) packages are available.

But to broaden the Interpro's appeal, Intergraph, now offers a workstation based on Fairchild's 32-bit chip. Intergraph's executive vice president for engineering, John Thorington, is quick to say Intergraph has not abandoned National. Intergraph will sell both versions — the Clipper will be postioned as a high-end $25,000 machine, the National as a $15,000 entry model — and they both run the same software.

National says that there are no hard feelings. "Basically, what we consider the volume workstation business that Intergraph will be doing is still 32000-based," says Anne Wagner, marketing director for the 32000 line. "They are still good customers," she says of Intergraph, "they take a lot of product." Wagner says Intergraph is committed to volume purchase agreements, and that National recently upgraded Intergraph's Unix license.

"We have to position ourselves where we don't care where the chip comes from," Thorington says. The Interpro's architecture specifically separates the CPU, permitting easy chip switches. Since there was no Clipper in the winter of 1983, when the first specs were drawn up for the Interpro, Intergraph chose National for its floating point capability, Thorington says. Last year, the Clipper's 5-million instructions per second (MIPS) speed and floating point won him over.

The sheer elegance of the Clipper charmed Thorington. He says that Fairchild "finessed rather than brute-forced" the speed into the chip. He explains that he means

Bernd Billmeyer

EXECUTIVE VICE PRESIDENT for ENGINEERING THORINGTON: "We have to position ourselves where we don't care where the chip comes from" get to market faster with its own machine, then Intergraph might be reselling DEC workstations today. DEC "was so late we really couldn't wait for them," Meadlock recalls. He says that DEC had an early workstation project that was "decimated" on two separate occasions by defections to Apollo Computer Inc., the company that first pioneered the concept of engineering workstations.

Maybe Meadlock should have waited, though. DEC may have been late to the market, but it looks like, once again, it may have set an industry standard. To date, Intergraph has sold only 1,000 Interpros, compared with DEC's VAXstation II, which should reach calendar year sales of 10,000 units, according to market reseach firm International Data Corp. in Framingham, Mass.

Meadlock, however, apparently had no qualms about moving into computer manufacturing. No novice in hardware design, Intergraph has always manufactured its own products to add on to DEC systems, including a line of sophisticated intelligent graphics terminals. Also, the company only buys the heart of a VAX from DEC; as much as 85% to 90% of the systems that Intergraph sells are made in Huntsville.

Hardware content is one of the things that has kept Intergraph's gross profit margins in the 60% range, Meadlock says, and he intends to keep it that way. "The only way to be successful at this size is not to sell only software," he says. Meadlock sees three kinds of CAD/CAM companies: software (what he imagines most companies will be), hardware (DEC, IBM, potential Japanese entrants and maybe Apollo and Sun) and those that sell both.

Margins are not the only reason. Meadlock fears for any company that loses control of the total system. "Look at Daisy," he says, a CAE start-up which has recently suffered several poor financial quarters. "They've tried to do their own [hardware], they've tried to put it on DEC's, on IBM's, and they've just been flopped off the wall."

So why does Meadlock think he can succeed with his own machine when other CAE companies have failed? The answer is easy, Meadlock says. He claims he has the best workstation on the market. "Right now nobody's in the same league," he says. And some analysts agree. James Stone of Shearson Lehman Brothers Inc. calls the Interpro 32C (due to start shipping in volume this quarter) "a fantastic piece of hardware." He says that its 5 MIPS (million instructions per second) performance and $25,000 price tag combine for twice the price/performance ratio of anything from Apollo, DEC or Sun, the three major workstation suppliers. Or IBM, for that matter. Intergraph may have a little trouble convincing customers to deny DEC or IBM but Stone says that, "Against two times price/performance, principles may give a little bit."

If Meadlock is correct in his timing, adds analyst Heymann at Drexel, the industry is just at the point where it will start to accept generic Unix-based hardware. Meadlock is just "keeping his foot in the door with DEC, while he completes the Unix shift," Heymann says.

Meanwhile, Daratech's Foundyller suggests that Meadlock may be looking even further ahead beyond the CAD/CAM industry. One day, he suggests, Meadlock may want to turn Intergraph into a mainstream computer company. But Meadlock says he is not interested in such grandiose schemes. He is just a simple country boy who wants to overtake IBM in CAD/CAM and CAE. ☐

Fairchild used rather ordinary process technology — 2 micron CMOS — and squeezed the performance into the Clipper via its architecture. The design combines reduced- and complex-instruction sets computer features into a supercomputer-type scheme. That description is not surprising, considering the Fairchild design team came from Cray Research Inc.

Thorington says he shopped around briefly last summer, meeting with Motorola Corp. and MIPS Computer Systems Inc. the same week before settling on Fairchild. Motorola powers the workstations of Apollo Computer Inc. and Sun Microsystems Inc. The MIPS chipset will be the guts of new machines from Prime Computer Inc. and Silicon Graphics Inc.

The Clipper module is packed with surface-mounted components to take the same space as the National chip-set. Fairchild had coincidentally used the same compilers and code generators as National, so the Unix match was very close.

Thorington says that Intergraph worked much more closely with Fairchild than with National, or DEC for that matter. Fairchild marketing director Tom Miller calls the resulting Intergraph/Fairchild relationship almost Japanese in character. There is a two-year joint development and volume purchasing agreement now, but during earlier stages no money changed hands. Fairchild is also debugging the Clipper on six Interpros, moving its CAE/CAD setup from a variety of vendors over to Intergraph.

Fairchild already has plans for the Clipper architecture that permit an upgrade path of 15 MIPS to 30 MIPS. ☐

What Intergaph brings to the CAE party

What Intergraph Corp. brings to CAE — besides an entire electromechanical design set-up from the same supplier — is an object-oriented database.

The chief benefit of the database, according to Intergraph, is what the industry calls a correct-by-construction approach. That is, a set of design rules that are incorporated into the objects of the database. Rather than completing a design and then sending it off to a larger computer for rule-checking, the object informs the engineer if he is violating a rule when he violates it, eliminating an extra step. The complexity of such an approach requires the high performance of the Interpro.

"It's head and shoulders above anything everybody else in the business has," says L.F. Rothschild, Unterberg, Towbin's Peter Schleider. Competitor William Parzybok, in charge of Hewlett-Packard's CAE effort until a recent reorganization, calls it one of the only two modern database systems on the market. The other, of course, is HP's — acquired when HP bought start-up Cericor Inc., a company Intergraph was once interested in, too.

Intergaph's other CAE pieces include integrated circuit layout tools from 50%-owned Tangent Systems Corp. and simulation software for analog chips from wholly owned Circuit Tools. ☐

Disk makers seek workstation access

Workstation vendors want gigabytes of storage for their design systems. The disk makers are a few megabytes shy

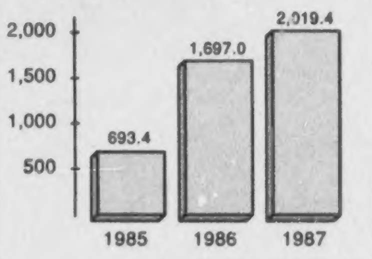
By Anne Knowles

Most manufacturers of scientific and engineering workstations would be happy with a gigabyte of disk drive memory in their machines. But most workstation makers, like Apollo Computer Inc. and Sun Microsystems Inc., have had to settle for a combination of 5.25-inch, internal Winchester disk drives and external 8-inch or 9-inch drives to satisfy their machine's insatiable thirst for memory storage.

However, advances in disk drive technology continue to put increasingly higher amounts of memory on smaller, desktop drives. What this means for manufacturers of small, high-capacity rigid disk drives is broadening opportunities in the workstation arena. "As 5.25-inch drives and half-height drives, continue to increase in capacity, workstation vendors will shift to those drives, from 8-inch and 9-inch product," says Patrick McMahon, general manager of marketing support for Minneapolis-based Control Data Corp.'s storage products group.

Spurring the shift is both storage capabilities and disk drive format. "In the workstation arena, there is no ceiling or limit on the demand for capacity," says Robert Teal, vice president of marketing at Maxtor Corp., a San Jose, California-based maker of high-capacity, 5.25-inch rigid disk drives. Workstation makers, says Teal, want higher resolution color graphics which require more and more data storage capacity. Yet, because workstations are multiuser desktop computers, the machines are, "limited to a footprint the size of a typewriter," says Teal.

> "In the workstation arena, there is no ceiling or limit on the demand for capacity"
>
> Robert Teal of Maxtor


Growth in 5.25-inch, 30 MB to 100 MB drives levels off...

(Unit shipments in thousands)

Source: Disk/Trend Inc.

Today, though, the most commonly used workstation drive is an 85 megabyte (MB), 5.25-inch Winchester, says James N. Porter, president of market research firm, Disk/Trend Inc. in Los Altos, Calif.

Most high-capacity disk drive makers offer 85 MB, 5.25-inch drives but the leader, with over 50% of the market, say analysts, is Micropolis Corp., a drive manufacturer in Chatsworth, Calif. About 75% of its sales, says Chester Baffa, vice president of marketing and sales, can be attributed to its 85 MB product, the 1325.

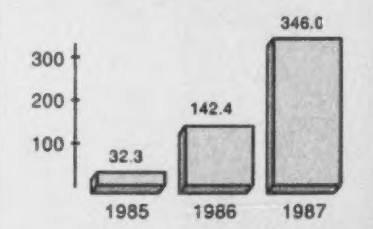
About 60% of Micropolis' business, guesses Baffa, is with workstation vendors. "We have about 10% of the workstation market," estimates Baffa. Few would argue with him. "If you look at who is doing high volume," sales in the workstation arena, says Baffa, you would find the names on Micropolis' customer list.

Apollo, Digital Equipment Corp., MASSCOMP and Sun all buy drives from Micropolis. DEC, which buys Micropolis drives for a number of systems, including the MicroVax II, represented nearly half of Micropolis' 1986 first quarter $50 million sales. Analysts lament that Micropolis is dangerously dependent upon DEC, which also buys drives from Maxtor. But Baffa says that Micropolis' percentage of DEC sales will drop to the "high teens " by year-end. Says Baffa: "That's not terribly uncomfortable."

Another 15% of Micropolis' sales are from its 170 MB, 5.25-inch drive. Disk/Trend's Porter expects that 85 MB drives will soon be replaced by 170 MB as the staple product for workstation vendors. In the 100 MB to 300 MB market, says Porter, Maxtor has garnered 19.2% of the worldwide market, second to Fujitsu's leading 26.9% share.

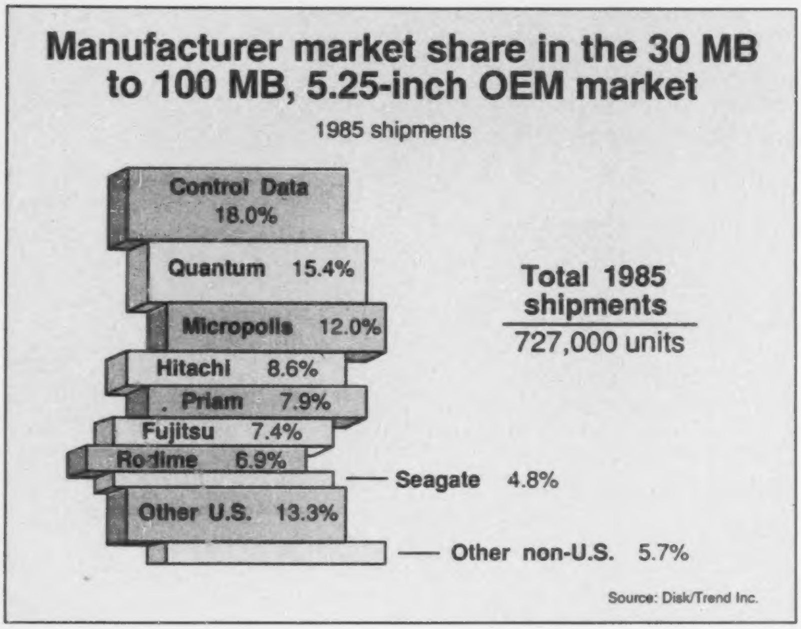
Although Maxtor offers an 85 MB drive, says Teal, the company concentrates on the high-end with the majority of their volume sales in the 100 MB to 300 MB range. Maxtor's original equipment manufacturer (OEM) deals include workstation makers Apollo, General Electric's Calma Co., DEC and Intergraph Corp. "The combination of workstations and graphics is our fastest growing segment," says Teal. One-third of Maxtor's $85.2 million in 1986 revenue, estimates Teal, was from workstation vendors.

Other industry observers, like John


...while the market for 5.25-inch, 100 MB to 300 MB drives takes off

(Unit shipments in thousands)

Source: Disk/Trend Inc.



Manufacturer market share in the 30 MB to 100 MB, 5.25-inch OEM market

1985 shipments

Source: Disk/Trend Inc.

Hagerman, director of product marketing at Priam Corp., a disk drive manufacturer in San Jose, believe that workstation makers may bypass 170 MB drives and start using 382 MB drives as their cornerstone offering. Maxtor's Teal thinks 5.25-inch Winchester drives can eventually be pushed to 2 gigabytes of storage. Other manufacturers are skeptical but Maxtor has already announced a 760 MB, 5.25-inch drive. Available in volume shipments in March, Maxtor's XT-8000E will be the highest capacity, 5.25-inch drive on the market.

A formal controversy

In addition to the controversy over storage capacity limitations, disk drive manufacturers argue over which form factor will rein supreme. CDC's McMahon, for example, believes that workstation makers will move toward the half-height, 5.25-inch product because it shrinks the size of the drive while retaining high capacity. Maxtor's Teal believes that half-height products will not have a chance to mature before 3.5-inch drives attain high enough capacities to attract vendors. The highest capacity for 3.5-inch drives available today, says Teal, is a 40 MB drive. But by the third quarter of 1987, Maxtor expects to announce a 3.5-inch drive in excess of 100 MB.

Others see potential in nascent optical storage technology. Peter Lloyd, president of Optimem, a Sunnyvale, California-based maker of 12-inch optical drives, says that he has, "talked to the majority of well-known workstation makers." Their initial interest, says Lloyd, is in current, write-once product for archival storage. He expects Optimem's next generation product — a 5.25-inch drive with erasable media — to garner "a large segment of business," in the workstation market. Lloyd says that Optimem will announce that product in the beginning of 1987 and volume production will be available by year-end.

But Micropolis' Baffa is wary of it all. "The trend in that business [workstations] is clearly not toward 3.5-inch or optical," says Baffa. "Three and a half-inch is not going to be able to support the kind of storage they need for a long time," explains Baffa. And optical storage, he says, is far too slow to be considered viable.

Who buys from whom

Workstation manufacturer	Disk drive sources
Apollo	CDC, Maxtor, Micropolis, Priam
DEC	Maxtor, Micropolis
Hewlett-Packard	Internal, Priam
IBM (for RT PC)	Internal
MassComp	Fujitsu, Micropolis, NEC
Silicon Graphics	Fujitsu, Hitachi, Priam, Tandon
Sun Microsystems	Fujitsu, Micropolis

Source: Workstation and disk drive manufacturers

Then there are diskless workstations offered by workstation makers such as Apollo and Sun. The idea, says Vicki Brown, a workstation analyst with International Data Corp. in Framingham, Mass., is to lower the cost per workstation. Diskless workstations access memory headquartered at a central server. Access time is slower, concedes Brown, but it allows manufacturers to offer systems below $10,000.

But most drive manufacturers do not believe diskless workstations will become pervasive enough to have an impact on their business. Priam's Hagerman contends that bandwidth limitations on the bus between server and workstation slow the process down too much. David Vellante, a disk drive analyst with IDC, says that networking software required for diskless nodes could negate any cost savings that the system offers.

A standard controversy

The interface standard problem is another evolving factor in the disk drive market today. Three standards, say observers, are emerging in the high-capacity, 5.25-inch rigid disk drive market. The first, the ST-412, is an IBM interface standard that is used on approximately 90% of all drives shipped, estimates Priam's Hagerman. But the ST-412, says Maxtor's Teal, has a bottleneck that slows transfer rates.

The two remaining drive interfaces used today — the Enhanced Small Device Interface (ESDI) and Small Computer Systems Standard (SCSI) — share the remaining 10% of shipments. Both are faster than the dominant ST-412 standard. The primary difference between the two, says IDC's Vellante, is that SCSI drives have embedded controllers and ESDI drives do not. The SCSI interface allows for off-the-shelf products that are quicker to market. But some systems vendors, says Vellante, want to design their own controllers that can be put into ESDI drives. Priam's Hagerman anticipates vendors shifting toward both ESDI and SCSI, and away from ST-412.

Also gaining momentum in the disk drive market are Japanese vendors. While Fujitsu and Hitachi have both been dominant in the worldwide disk drive market, they have not, until re-

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cently, been a force in the U.S. market. "The Japanese came over here with different standards," says IDC's Vellante, which were incompatible with existing systems. The Japanese manufacturers are just beginning to develop product here, says Vellante, and when the supermicrocomputer takes off in Japan, he believes that Japanese disk drive makers may find greater success here in the States.

So far, though, Fujitsu has found some popularity through its Eagle drive, a 10.5-inch, 474 MB drive reportedly used by Sun. MASSCOMP also buys drives from both Fujitsu and NEC Corp. And Silicon Graphics purchases drives from Fujitsu and Hitachi.

The interface standard problem is another evolving factor in the disk drive market

And then there is always the workstation manufacturers themselves. Most are too small to consider manufacturing disk drives, which are "not easy and not cheap to make," says IDC's Vellante. But because disk drives can also be the most costly component added onto a system, there is incentive for large manufacturers to make their own.

This, of course, could have a significant impact on high-capacity, drive manufacturers that universally depend on high-volume OEM sales. IBM already manufactures all of its drives used on its engineering workstation, the RT PC. Hewlett-Packard Co., which buys some 5.25-inch 24 MB and 55 MB drives from Priam, makes its own high-capacity, and higher margin, drives. And DEC, which does not make any 5.25-inch drives, is rumored to be developing 5.25-inch for inhouse production.

For both Maxtor and Micropolis that could mean trouble. But Micropolis' Baffa, who ranks DEC as the company's biggest customer, would not be the least surprised by such a decision. He claims no knowledge of DEC's intentions, but says, "DEC will absolutely manufacture its own [5.25-inch] disk drives." If DEC is serious about drive manufacturing, says Baffa, it will have to go to 5.25-inch. "Higher dimensions won't be where the world will be," says Baffa. "My perception is that it's a logical business decision for them." ☐

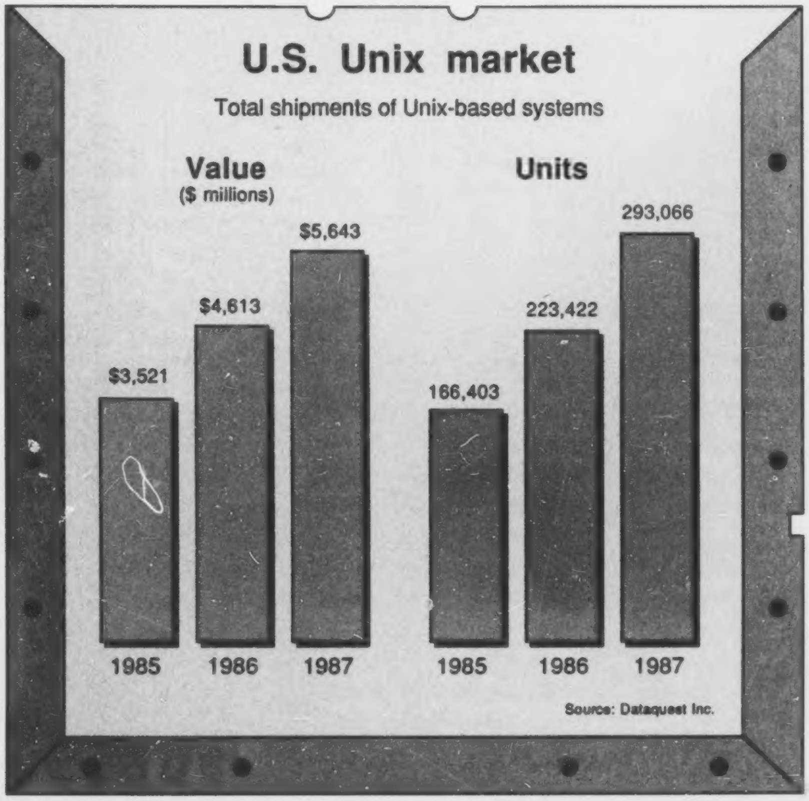
Unix: Portable software for a stable market

After several false starts, Unix is now the operating system of choice for numerous U.S. computer manufacturers

By Anne Knowles

Unix — the operating system developed by AT&T Bell Laboratories — has been long in coming. Ever since AT&T began licensing it to commercial manufacturers in 1973, industry watchers have predicted Unix would become a *de facto* standard in software used to control the internal functions of a computer. A portable operating system that can be adapted to different size systems from different makers, Unix was labeled the answer to an end-user's dream.

But every year the market for Unix-based systems has been about half what analysts projected. Today, though, the forces necessary to drive the Unix market are gaining momentum. Customers with clout — like General Motors Corp. (GM) and the U.S. government — demand it. And major manufacturers — like Digital Equipment Corp. (DEC) and IBM — sell it.


U.S. Unix market

Total shipments of Unix-based systems

Source: Dataquest Inc.

THE MARKET

Until recently, Unix was not an ideal operating system for commercial applications. It is a difficult operating system for the nontechnical user due to what many call its "cryptic commands," — the puzzling instructions a user needs to follow in order to use Unix. It suffers from a lack of application packages. Paul Cubbage, an analyst with Dataquest Inc., in San Jose, Calif., estimates that there are between 500 and 1,000 Unix application packages but among those there are only 100 to 200 different types.

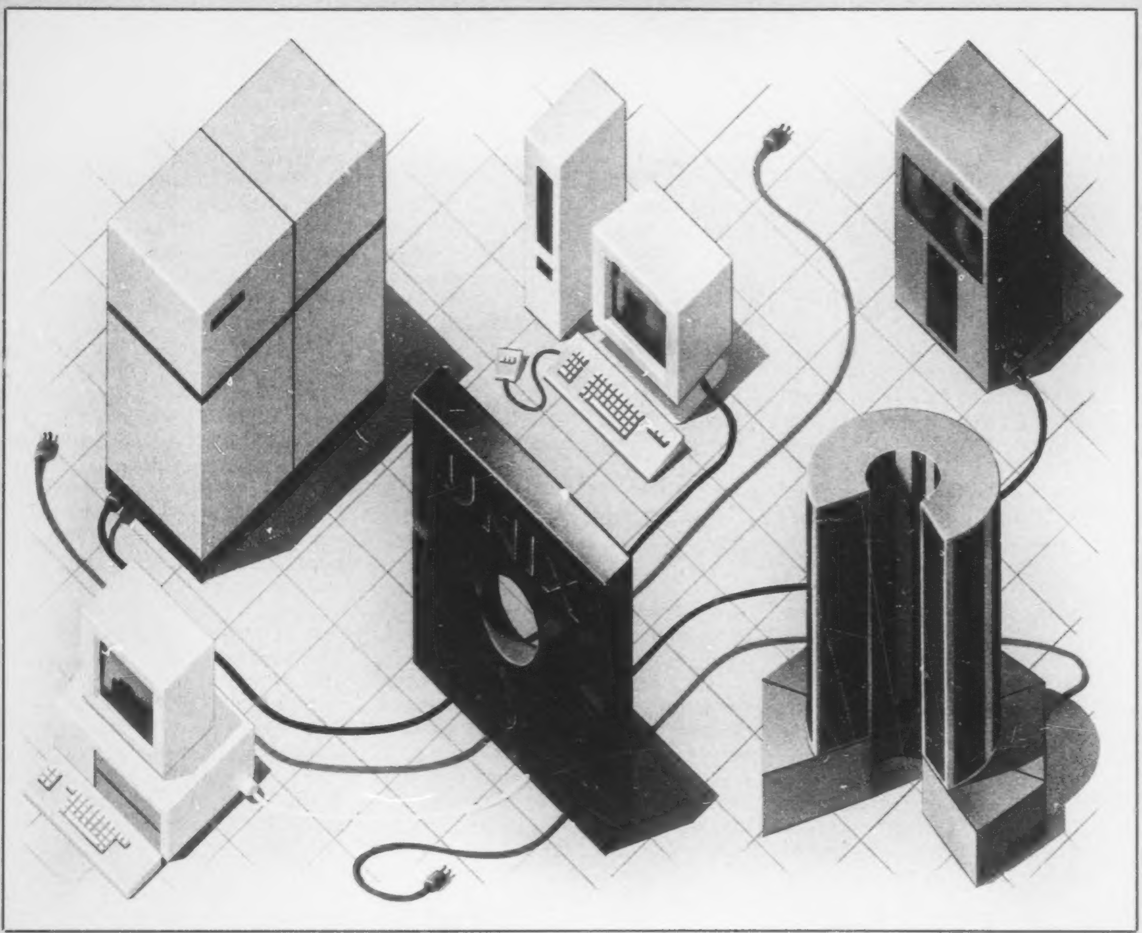
And Unix, as licensed from AT&T, did not have key security features necessary for commercial purposes until AT&T introduced its second rewrite of System V. And until AT&T brought out its latest version this summer, christened Release 3, Unix was not equipped for networking.

Ironically, though, Unix was first sold by supermicrocomputer manufacturers targetting commercial markets. When 16-bit microprocessors became available and start-ups like Altos Computer Systems, Fortune and Plexus Computers Inc. began marketing systems based on them, Unix was their operating system of choice. And the commercial arena was their market of choice.

"CP/M [a single-user operating system used extensively on 8-bit computers] was not appropriate for multiuser systems," says Robert Marsh, chairman and founder of Plexus, which negotiated the first distribution license for Unix with AT&T. "We were familiar with Unix and AT&T made it available on terms we could tolerate."

Altos experienced the same process. "We were selling systems with MP/M

(Continued)



Setting the standard

Creating a cohesive, coherent network of computers is not an easy task. Many blame the current slump in the computer industry on that very fact. While Unix does not provide the answer to the problem, some say it could be part of the solution.

Operating systems are programs that control the operations of a computer. Many of them are written in machine language which is specific to each computer. They are optimized to run on that hardware and they are difficult to transport to other, different types of hardware.

Unix, on the other hand, is a portable operating system. Most of it was written in the programming language C, developed for Unix. Companies license the operating system's source code — the statements written in programming language — from AT&T. The operating system can then be adapted to any computer by using a software compiler which translates Unix's source code into that computer's unique machine language.

The variety of systems running versions of Unix bears witness to the operating system's portability. Cray Research Inc. uses it on its Cray 2 supercomputer while IBM runs a version of Unix developed by interactive Systems Corp., called AIX, on its RT PC engineering workstation and Xenix, from Microsoft, on its PC AT. Digital Equipment Corp. offers Ultrix, its Unix-like system, on its family of VAX superminicomputers and Amdahl Corp., in 1981, was the first vendor to port Unix (its version is called UTS) to a mainframe.

Software written for Unix is also portable. Ideally, any Unix software application package should be able to run on any Unix-based machine.

Unix is also a good operating system for software development, originally developed by Bell Laboratories in 1969 for that purpose. It is supported by a set of software tools that encourages development of application packages for it. And AT&T began licensing the operating system, for an affordable fee, to universities in the early 1970s. Unix became firmly entrenched in university computer labs and created a large pool of trained and loyal programmers.

In fact, Unix owes much of its popularity to its roots in academia. Its primary contribution is as a standard for the industry. Certain features incorporated in Unix are by no means unique to it. Multitasking — the ability to perform more than one job at at a time — and software development tools can be found on many operating systems. "Unix has an edge up because it was used in education. People left there and went into industry," says Jeffrey Bork, director of systems marketing at Altos Computer Systems.

Marty Braun

[a CP/M-like operating system]," says Jeffrey Bork, director of systems marketing at Altos. So Altos chose Unix. Both Altos and Plexus added enhancements to the system, including file locking for security and networking features, that made the offerings more attractive to commercial users. Commercial customers, says Altos' Bork, have always been "our bread and butter."

The majority of Plexus' sales, says Plexus' Marsh, go into data processing applications. But the U.S. government has always represented a substantial portion, about 20%, of Plexus' business.

Plexus is not the only Unix vendor doing business with the U.S. government. In search of a standard operating system, the U.S. government settled on Unix and now approximately 75% of all government requests for proposals stipulate Unix. AT&T alone has contracts with three federal agencies — Department of Agriculture, National Security Agency and U.S. Customs — for the company's 3B Unix-based systems valued at over $1.1 billion.

There is also considerable interest overseas by foreign computer manufacturers who, lacking software of their own, see Unix as a way into the American market. But for the moment, at least, it is still big name U.S. customers that have driven the market for Unix-based systems. AT&T and the Bell Operating Companies provided the impetus Digital Equipment Corp. needed to develop its Unix-like operating system called Ultrix. Before AT&T's divestiture it was DEC's biggest customer. AT&T wanted Unix and encouraged DEC to offer it, says Nils Noren, DEC's marketing manager for Ultrix. Despite the fact that AT&T has shifted to buying its own equipment since divestiture, and is no longer DEC's largest customer, about 22% of DEC's VAX computers are sold with Ultrix, estimates Dataquest's Cubbage.

Foreign computer manufacturers see Unix as a way into the American market

And now General Motors has also decreed that its factory floor is now a Unix shop. Even though Unix was not developed as a real-time operating system, GM wanted to standardize on an operating system that would enable the automaker to transport software across different vendors' hardware, says John Williams, senior manufacturing product engineer for advanced manufacturing at Chevrolet, Pontiac, GM of Canada. "It has been adopted as a strategic goal. Manufacturers don't absolutely have to have Unix," when bidding for contracts, says Williams. "But [contract awards] will be Unix unless a vendor can prove reason otherwise."

Unix's greatest success, however, has been in the scientific, engineering and education markets. The reasons for that are varied. Part of the reason is that AT&T licensed Unix to universities for a nominal fee. Unix developed a loyal following within the education field and the programmers and engineers entering the job market were trained on it.

Systems that are used almost exclusively for technical applications — supercomputers and minisupercomputers — often use Unix. Cray Research Inc. of Minneapolis, which has about 70% of the worldwide supercomputer market, added Unix on its Cray 2 supercomputer despite the fact that its propietary system, COS (Cray Operating Systems), dominates the market. And the relatively young minisupercomputer manufacturers chose to develop systems based on Unix rather than risk acceptance of yet another proprietary operating system. The one exception, Scientific Computer Systems Corp., uses an operating system compatible to Cray's proprietary COS.

Another relatively young market — computer aided engineering and design (CAE, CAD) — is moving toward Unix. Some of the players — Intergraph Corp., Sun Microsystems Inc. and Valid Logic Systems Inc. — always used Unix and others — Apollo Computer Inc., Daisy Systems Corp. and Mentor Graphics Corp. — who started out on proprietary operating systems have converted to Unix. And IBM's late entrant into the market, the RT PC, runs AIX, a Unix-like operating system developed by Inter-

U.S. Unix market — dollar value

Shipments of Unix-based systems ($ millions)

	1985	1986	1987
Mainframes	$241	$303	$393
Business unit (64-128 users)	142	199	240
Large department (32-64 users)	172	264	335
Small department (20-32 users)	213	297	357
Work group (2-10 users)	2,138	2,552	3,050
Single-user workstation	517	836	1,044
Personal computer	98	162	224

U.S. Unix market — unit shipments

Shipments of Unix-based systems (units)

	1985	1986	1987
Mainframes	71	89	114
Business unit (64-128 users)	282	423	564
Large department (32-64 users)	844	1,303	1,700
Small department (20-32 users)	4,347	6,224	7,689
Work group (2-10 users)	118,448	142,075	178,791
Single-user workstation	15,674	27,324	40,170
Personal computer	26,737	45,984	64,038

Source: Dataquest Inc.

PLEXUS' MARSH: Negotiated the first distribution license for Unix with AT&T

Tom Davis

active Systems Corp., in Santa Monica, Calif. "In workstations, Unix is where it is at," says James Groff, president of Network Innovations Corp., a developer of networking software in Cupertino, Calif.

COST OF ENTRY

Because Unix was designed to be free of hardware dependency, it is relatively easy to get up and running on any computer. Unix is written in the programming language C which was developed in conjunction with the operating system. Both are machine independent, meaning they do not rely on specific hardware for their functions.

AT&T licenses the Unix source code, the instructions written in C programming language, to hardware manufacturers. For Unix System V, Release 3, AT&T's latest version of Unix, it costs $65,000 for the first central processing unit. If a vendor wants to adapt, or "port" Unix to a second system, the next license costs $20,000. Every CPU or computer model after that can be sublicensed for $2,000 each. The prices are set and initial costs remain stable.

Network Innovations' Groff estimates it requires two engineers about three months to port Unix to a computer. "All you have to do is get a C compiler," which translates Unix into a specific computer's machine language, says Groff. In contrast, most other operating systems, says Groff, are written in low-level machine language. To transport them to another computer with different machine language requires rewriting of the source code.

DEC ported Unix 4.2 BSD, a version of Unix developed at University of California at Berkeley, to its VAX architecture, which runs DEC's proprietary operating system, VMS. "There was a lot of bug fixing," says DEC's Noren. "But there really wasn't much to do because Unix has always run on VAX [computers]." Unix was developed at AT&T on DEC's PDP-11 minicomputers.

> AT&T has also been working closely with semiconductor manufacturers to put Unix on off-the-shelf processors

AT&T has also been working closely with semiconductor manufacturers to put Unix on off-the-shelf processors. Intel Corp.'s 80X86 series of processors now run Unix, including Release 3 which is being ported to Intel's 80386 32-bit chip. Unix has also been ported to Motorola's 68000 family and National Semiconductor Corp.'s 32000 series.

The long list of established vendors who have added Unix to their systems, says Groff, "is proof in the pudding," to Unix transportability. But that does not say Unix is a *fait accompli* on any system. IBM's mid-range System 36, for example, is "an anti-Unix machine," says Dataquest's Cubbage.

THE COMPETITION

AT&T has granted about 2,000 Unix licenses. That includes licenses to educational institutions, hardware vendors and end users. David Sandell, AT&T's director of technical sales support for Unix, estimates Unix is running on "well over 100 machines."

The adoption of Unix by major manufacturers has altered the competition. Plexus' Marsh says the company decided on Unix assuming the market for the systems would remain a niche. Because of that, projected Marsh, the players would be small. "I am sort of overwhelmed by the speed with which all major manufacturers have implemented Unix," says Marsh. "If I had known that," adds Marsh, "I might not have done it at all or I would have stuck to the low end."

Most manufacturers add enhancements to their flavor of Unix in order to differentiate their offerings. Barebones Unix lacks certain capabilities, which a vendor can develop, that preclude it from certain markets. Charles River Data Systems Inc. of Framingham, Mass., for example, has added real-time capabilities to its version of Unix. Altos developed Worknet, a networking enhancement similiar to AT&T's Remote File Sharing, incorporated into its Release 3. Plexus markets its Unix-based system for distributed processing. Honeywell Inc. developed a "user-friendly," menu-driven shell, called Easylife, for its new Unix-based multiuser systems.

DEC gave Ultrix DECnet communications systems support, added software tools and utilities and documentation, including a catalogue of over 100 third-party software application packages. Vendors can also speed up Unix, says DEC's Noren, by adding assembly (or machine) language to the program which customizes Unix to their machines. But, warns Noren, manufacturers have to be careful not to tamper too much with the operating system. Vendors "can add some value," says Noren. "But they can't put on bells and whistles that won't run in other environments."

Unix-based systems are also wrestling other operating systems for market share. While Unix is sold on single-user workstations and personal computers, application packages for PC-DOS, IBM's PC operating system, are growing at a faster rate than Unix packages, says Bonnie Digrius, an analyst with Input, a market research firm in Mountain View, Calif. But beyond single-user systems PC-DOS cannot rival Unix because it is not a multiuser system.

IBM's MVS controls the mainframe segment by sheer force of numbers: IBM has an estimated 76% share of that market. And the midrange — minicomputers and superminicomputers — scientific and engineering arena is dominated by DEC's VMS.

The commercial market for departmental systems, though, — again minis and superminis — is still fragmented, says Network Innovations' Groff, between DEC's VMS, the SSP operating system on IBM's System 36, Unix and a handful of other proprietary systems. It is in that area, says Groff, that Unix is "certainly not a foregone conclusion."

Dataquest's Cubbage thinks that Unix will never wrest control of those markets already established by other operating systems. "By the end of the decade," says Cubbage, "the operating systems that have infrastructures today — MVS, VMS, MS-DOS and Unix — will survive."

THE OBSTACLES

Unix has always been surrounded by controversy. Customers complain it is difficult to use. Manufacturers maintain it is inferior to their own, proprietary operating systems. But Unix has evolved and certain problems have been resolved.

Many technical problems for the commercial user were finally addressed when AT&T announced its second version of System V, called Release 2. Until then, Unix did not have key security features necessary for commercial environments. But Release 2 provided file and record locking, enabling the user to protect files from being tampered with by another user. And in Release 3 AT&T added two networking enhancements: Streams provides a hardware independent protocol for networking Unix-based systems and remote file sharing enables two Unix-based computers to share files and peripherals.

Other technical glitches continue to vex users. Unix is not easy to use for the end user; the instructions, or commands, a user has to give are puzzling. Unix also requires a lot of memory and on mainframes and minicomputers, where it needs two to six megabytes of memory, that can be expensive. But any system has its drawbacks and the issue of Unix's "cryptic commands," says Network Innovations' Groff, "is a red herring." In other words, such complaints are only a distraction from the real issue.

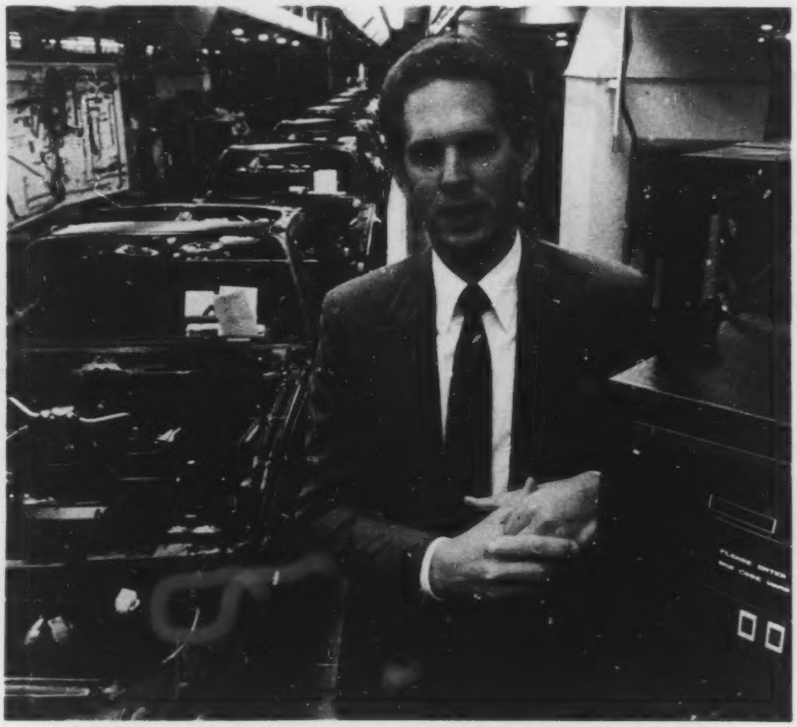
"The barriers are psychological, not technical," says Groff. For several years, Unix did not live up to the phenomenal growth forecasts projected by market researchers. In 1984, for example, actual shipments of Unix-based supermicrocomputers trailed 57% behind estimates, according to Frost & Sullivan Inc., a market research firm in New York City.

Another hurdle is the lack of Unix leadership in the industry. "AT&T hasn't been successful in marketing Unix-based minis," says Network Innovations' Groff. And while Unix found acceptance in technical markets, says Groff, "AT&T was dragging its feet on putting in commercial enhancements."

In addition, established manufacturers, who have tied their installed base to a proprietary operating system, have been reluctant to promote Unix. "They're [IBM and DEC] making the efforts [to provide Unix]," says James Meadlock, president of Intergraph Corp. in Huntsville, Ala., "but both of them would really like to see it die. Theirs is a totally defensive effort." Continues Meadlock: "The guys who really want Unix to succeed are the end users who want to believe they are buying a solution that doesn't tie them to one company."

"If we didn't offer it, somebody else would have," responds DEC's Noren.

But the forces necessary to establish Unix as a standard, says James Isaac, director of strategic marketing at Charles River Data, are in place. The Institute of Electrical and Electronic Engineers (IEEE) has set up a standards committee to establish a Unix standard called POSIX that incorporates features of both AT&T's Unix V and University of California at Berkeley's Unix 4.2 BSD. In April, the IEEE came out with a trial-use standard and by fall of 1987, says Isaac, a full-use standard will be completed. "You need three things to make a standard," explains Isaac. First, users, such as GM and the government, who require it. Second, vendors who have implemented it. And a clear definition, provided by the IEEE, of what it is. ☐



GM's WILLIAMS: Unix has been adopted as a strategic goal

Junebug Clark

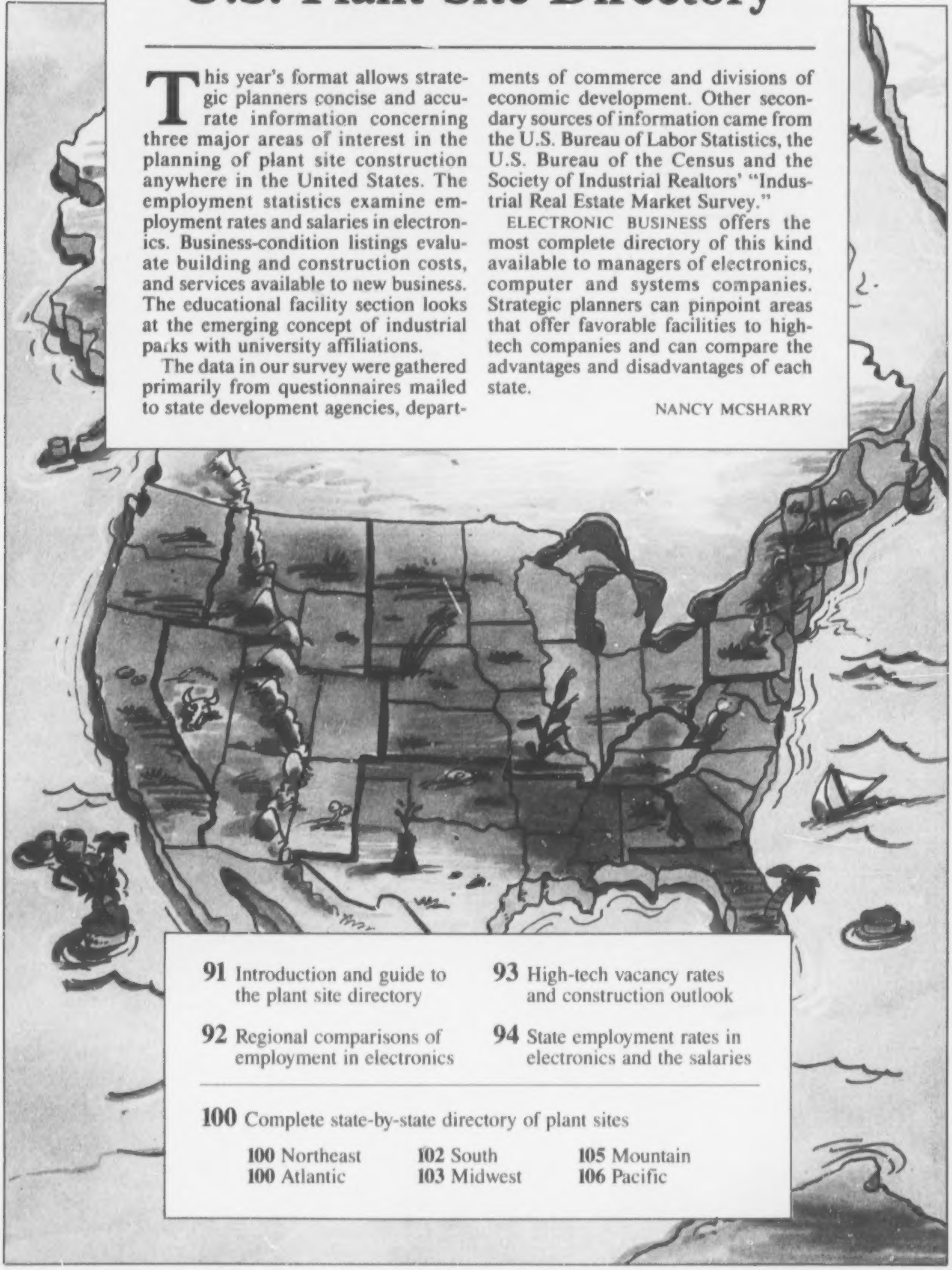
U.S. Plant Site Directory

This year's format allows strategic planners concise and accurate information concerning three major areas of interest in the planning of plant site construction anywhere in the United States. The employment statistics examine employment rates and salaries in electronics. Business-condition listings evaluate building and construction costs, and services available to new business. The educational facility section looks at the emerging concept of industrial parks with university affiliations.

The data in our survey were gathered primarily from questionnaires mailed to state development agencies, departments of commerce and divisions of economic development. Other secondary sources of information came from the U.S. Bureau of Labor Statistics, the U.S. Bureau of the Census and the Society of Industrial Realtors' "Industrial Real Estate Market Survey."

ELECTRONIC BUSINESS offers the most complete directory of this kind available to managers of electronics, computer and systems companies. Strategic planners can pinpoint areas that offer favorable facilities to high-tech companies and can compare the advantages and disadvantages of each state.

NANCY MCSHARRY



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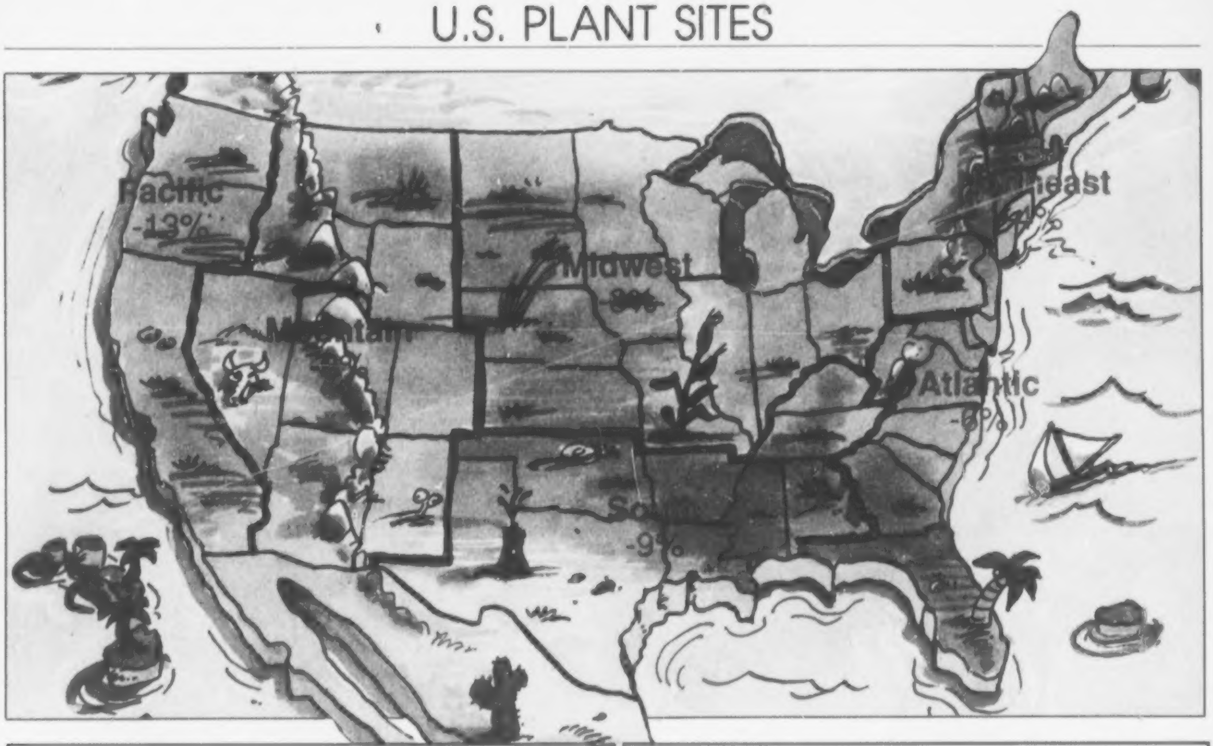
U.S. PLANT SITES



Total 1985 employment in electronics

Northeast	
Connecticut	77,500
Maine	N/A
Massachusetts	170,600
New Hampshire	25,800
New Jersey	93,600
New York	279,800
Pennsylvania	151,900
Rhode Island	11,200
Vermont	4,500
Total	**814,900**

Atlantic	
Delaware	1,428
Florida	59,800
Georgia	25,600
Maryland	20,900
North Carolina	57,700
South Carolina	35,100
Virginia	19,700
West Virginia	6,000
Total	**226,228**

South	
Alabama	19,700
Arkansas	16,800
Kentucky	33,700
Louisianna	10,100
Mississippi	14,300
Oklahoma	39,400
Tennessee	46,500
Texas	159,500
Total	**340,000**

Midwest	
Illinois	184,600
Indiana	77,500
Iowa	42,600
Kansas	10,400
Michigan	145,900
Minnesota	89,900
Missouri	43,200
Nebraska	10,600
North Dakota	N/A
Ohio	189,200
South Dakota	1,007
Wisconsin	111,500
Total	**906,407**

Mountain	
Arizona	41,481
Colorado	25,400
Idaho	6,000
Montana	N/A
Nevada	N/A
New Mexico	2,800
Utah	15,500
Wyoming	N/A
Total	**91,181**

Pacific	
Alaska	N/A
California	344,400
Hawaii	N/A
Oregon	30,200
Washington	27,600
Total	**402,200**

Source: U.S. Department of Labor, Bureau of Labor Statistics

Percentage change – 1985/1986

Northeast	
Connecticut	-5%
Maine	N/A
Massachusetts	+3%
New Hampshire	-1%
New Jersey	-6%
New York	-6%
Pennsylvania	-6%
Rhode Island	+2%
Vermont	-7%
Average	-4%

Atlantic	
Delaware	N/A
Florida	-1%
Georgia	-1%
Maryland	-11%
North Carolina	-5%
South Carolina	-3%
Virginia	-2%
West Virginia	-6%
Average	-6%

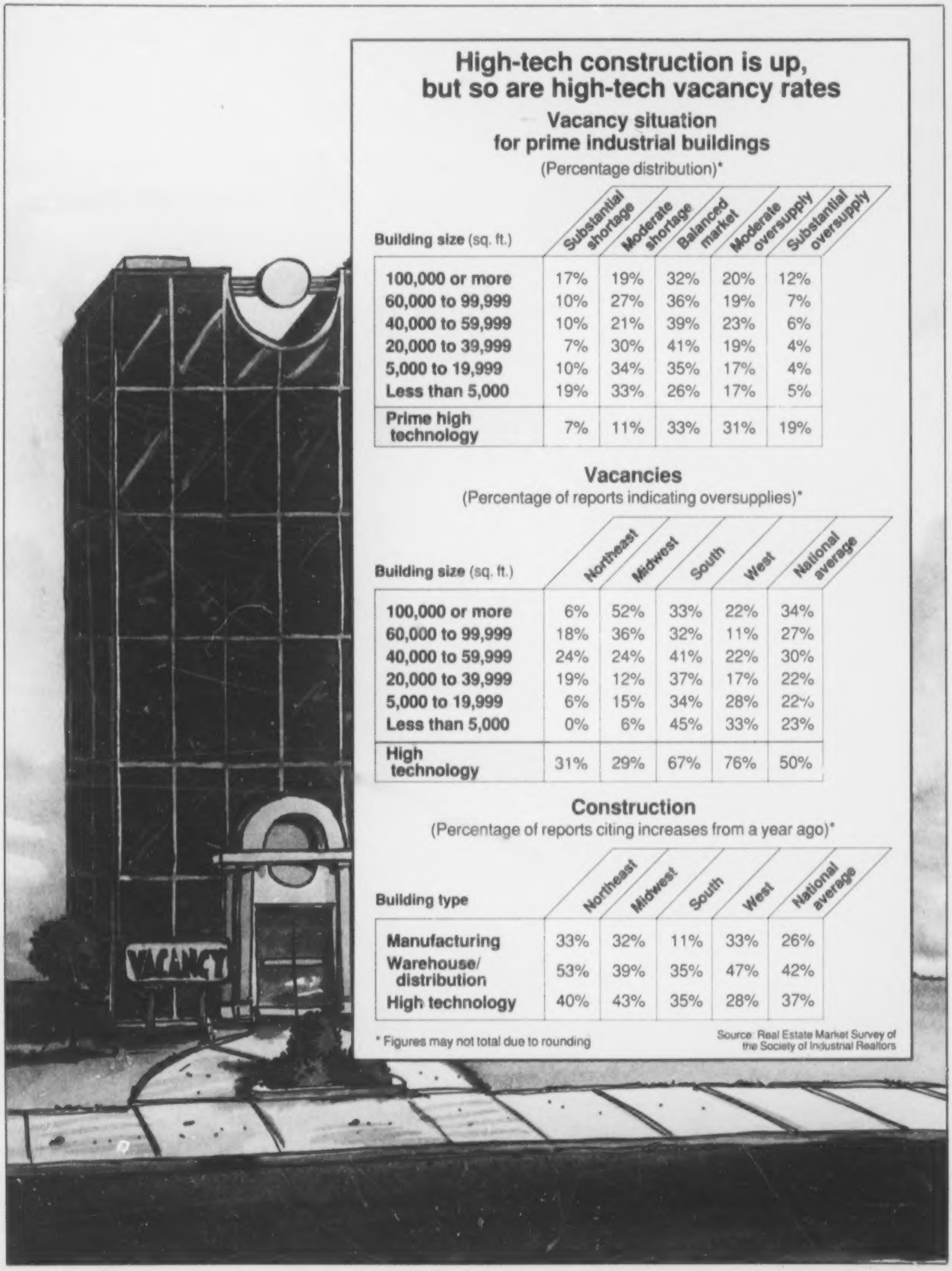
South	
Alabama	+2%
Arkansas	-1%
Kentucky	-7%
Louisianna	-13%
Mississippi	-6%
Oklahoma	-12%
Tennessee	-4%
Texas	-12%
Average	-9%

Midwest	
Illinois	-3%
Indiana	+8%
Iowa	-5%
Kansas	N/A
Michigan	-2%
Minnesota	-10%
Missouri	-2%
Nebraska	-13%
North Dakota	N/A
Ohio	-5%
South Dakota	N/A
Wisconsin	+1%
Average	-3%

Mountain	
Arizona	N/A
Colorado	-2%
Idaho	-10%
Montana	N/A
Nevada	N/A
New Mexico	-11%
Utah	N/A
Wyoming	N/A
Average	-8%

Pacific	
Alaska	N/A
California	-14%
Hawaii	N/A
Oregon	-6%
Washington	+1%
Average	-13%

Change is between the first eight months of each year



High-tech construction is up, but so are high-tech vacancy rates

Vacancy situation for prime industrial buildings

(Percentage distribution)*

Building size (sq. ft.)	Substantial shortage	Moderate shortage	Balanced market	Moderate oversupply	Substantial oversupply
100,000 or more	17%	19%	32%	20%	12%
60,000 to 99,999	10%	27%	36%	19%	7%
40,000 to 59,999	10%	21%	39%	23%	6%
20,000 to 39,999	7%	30%	41%	19%	4%
5,000 to 19,999	10%	34%	35%	17%	4%
Less than 5,000	19%	33%	26%	17%	5%
Prime high technology	7%	11%	33%	31%	19%

Vacancies

(Percentage of reports indicating oversupplies)*

Building size (sq. ft.)	Northeast	Midwest	South	West	National average
100,000 or more	6%	52%	33%	22%	34%
60,000 to 99,999	18%	36%	32%	11%	27%
40,000 to 59,999	24%	24%	41%	22%	30%
20,000 to 39,999	19%	12%	37%	17%	22%
5,000 to 19,999	6%	15%	34%	28%	22%
Less than 5,000	0%	6%	45%	33%	23%
High technology	31%	29%	67%	76%	50%

Construction

(Percentage of reports citing increases from a year ago)*

Building type	Northeast	Midwest	South	West	National average
Manufacturing	33%	32%	11%	33%	26%
Warehouse/ distribution	53%	39%	35%	47%	42%
High technology	40%	43%	35%	28%	37%

* Figures may not total due to rounding

Source: Real Estate Market Survey of the Society of Industrial Realtors

Northeast

	Population	Total civilian workforce	Total employment in electronics	Average annual salary per employee		Percentage of workforce unemployed	Percentage of workforce unionized
				in total workforce	in electronics		
Connecticut	2,470,000	1,711,000	N/A	N/A	N/A	4.9%	N/A
Maine	874,000	552,000	N/A	N/A	N/A	5.4%	N/A
Massachusetts	4,549,000	3,061,000	340,100	$19,635	$21,688	3.9%	N/A
New Hampshire	756,000	537,000	24,500	$18,075	$20,654	3.9%	15.0%
New Jersey	5,891,000	3,853,000	86,732	N/A	N/A	5.7%	19.0%
New York	13,681,000	8,308,000	156,500	$25,900	$25,900	6.5%	38.7%
Pennsylvania	9,192,000	5,519,000	36,153	$18,434	$24,342	8.0%	41.1%
Rhode Island	748,000	500,000	12,100	N/A	N/A	4.9%	12.0%
Vermont	401,000	277,000	13,300	$15,800	$28,500	4.8%	18.0%

Atlantic

	Population	Total civilian workforce	Total employment in electronics	Average annual salary per employee		Percentage of workforce unemployed	Percentage of workforce unionized
				in total workforce	in electronics		
Delaware	469,000	315,000	1,428	N/A	N/A	5.3%	14.2%
Florida	8,903,000	5,338,000	59,800	$17,682	$25,125	6.0%	9.6%
Georgia	4,344,000	2,865,000	25,600	N/A	N/A	6.5%	N/A
Maryland	3,330,000	2,253,000	20,900	N/A	N/A	4.6%	18.6%
North Carolina	4,653,000	3,206,000	57,700	$16,000	$21,300	5.4%	4.8%
South Carolina	2,431,000	1,563,000	35,100	N/A	N/A	6.8%	N/A
Virginia	4,233,000	2,872,000	19,700	N/A	N/A	5.6%	N/A
West Virginia	1,465,000	765,000	6,000	$17,995	$23,581	13.0%	34.4%

U.S. PLANT SITES

Midwest

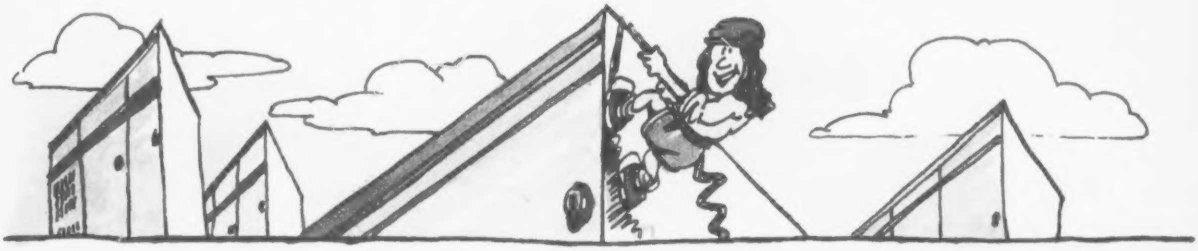
	Population	Total civilian workforce	Total employment in electronics	Average annual salary per employee		Percentage of workforce unemployed	Percentage of workforce unionized
				in total workforce	in electronics		
Illinois	8,644,000	5,673,000	118,303	$18,657	$20,764	9.0%	31.0%
Indiana	4,101,000	2,735,000	86,200	N/A	$24,224	7.9%	N/A
Iowa	2,154,000	1,416,000	N/A	N/A	N/A	8.0%	N/A
Kansas	1,804,000	1,244,000	10,400	$17,333	$16,840	5.0%	10.0%
Michigan	6,794,000	4,352,000	35,800	N/A	$22,090	9.9%	33.0%
Minnesota	3,137,000	2,234,000	N/A	N/A	N/A	6.0%	N/A
Missouri	3,788,000	2,472,000	51,500	$20,789	$20,064	6.4%	18.5%
Nebraska	1,182,000	813,000	9,415	$18,923	$19,034	5.5%	18.2%
North Dakota	489,000	336,000	N/A	N/A	N/A	5.9%	N/A
Ohio	8,065,000	5,130,000	N/A	N/A	N/A	8.9%	N/A
South Dakota	510,000	347,000	1,007	$13,532	$11,000	5.1%	3.5%
Wisconsin	3,574,000	2,374,000	49,300	$22,152	$21,684	7.2%	28.0%

South

	Population	Total civilian workforce	Total employment in electronics	Average annual salary per employee		Percentage of workforce unemployed	Percentage of workforce unionized
				in total workforce	in electronics		
Alabama	2,972,000	1,803,000	N/A	N/A	N/A	8.9%	N/A
Arkansas	1,746,000	1,051,000	N/A	N/A	N/A	8.7%	N/A
Kentucky	2,744,000	1,695,000	14,500	$16,754	N/A	9.5%	16.0%
Louisiana	3,199,000	1,987,000	7,400	$17,769	$23,821	11.5%	16.0%
Mississippi	1,855,000	1,121,000	1,600	$14,650	$19,700	10.3%	16.0%
Oklahoma	2,419,000	1,573,000	9,700	$20,838	$20,997	7.1%	N/A
Tennessee	3,583,000	2,245,000	38,356	$16,646	$18,921	8.0%	15.8%
Texas	11,718,000	8,053,000	115,200	$20,160	$21,170	7.0%	16.0%

Mountain

	Population	Total civilian workforce	Total employment in electronics	Average annual salary per employee		Percentage of workforce unemployed	Percentage of workforce unionized
				in total workforce	in electronics		
Arizona	2,354,000	1,477,000	41,481	$18,335	$25,495	6.5%	N/A
Colorado	2,386,000	1,720,000	N/A	N/A	N/A	5.9%	N/A
Idaho	707,000	471,000	5,600	$17,500	$27,300	7.9%	12.0%
Montana	603,000	405,000	N/A	N/A	N/A	7.7%	N/A
Nevada	709,000	509,000	N/A	N/A	N/A	8.0%	N/A
New Mexico	1,032,000	646,000	4,987	$17,404	$24,188	8.8%	N/A
Utah	1,062,000	730,000	15,500	$16,800	$21,600	5.9%	10.0%
Wyoming	361,000	253,000	N/A	N/A	N/A	7.1%	N/A



Pacific

	Population	Total civilian workforce	Total employment in electronics	Average annual salary per employee		Percentage of workforce unemployed	Percentage of workforce unionized
				in total workforce	in electronics		
Alaska	346,000	253,000	N/A	N/A	N/A	9.7%	N/A
California	19,577,000	12,937,000	N/A	N/A	N/A	7.2%	N/A
Hawaii	734,000	481,000	N/A	N/A	N/A	5.6%	N/A
Oregon	2,042,000	1,327,000	33,677	$17,400	$23,774	8.8%	N/A
Washington	3,280,000	2,105,000	N/A	N/A	N/A	8.1%	N/A

Northeast

Connecticut

Additional information

Name: Mark Fineberg

Agency: Connecticut Department of Economic Development

Address: 210 Washington Street, Hartford, Conn. 06106

Phone: (203) 566-5546

Maine

Additional information

Agency: State Development Agency

Address: 193 State Street, Augusta, Maine 04333

Phone: (207) 289-2656

Massachusetts

Business conditions

Average cost of industrial land (per acre) $44,000

Average construction costs (per square foot) $30

Number of state/local sponsored incubator programs 1

State/local start-up assistance available for new business . . . . Yes

Educational facilities

Number of four-year colleges and universities 110

Additional information

Name: William J. Sugrue

Agency: S.I.T.E. Program, Department of Commerce and Development

Address: Leverett Saltonstall Building, Government Center, 100 Cambridge Street, Boston, Mass. 02202

Phone: (617) 727-3215

New Hampshire

Business conditions

Average cost of industrial land (per acre) $27,500

Average construction costs (per square foot) $30

Number of state/local sponsored incubator programs 1

State/local start-up assistance available for new business . . . . Yes

Number of electronics companies 194

Educational facilities

Number of four-year colleges and universities 16

Industrial parks with university affiliations:

Industrial park: UNH Technology Park (proposed)

University affiliation: University of New Hampshire-Manchester

Address: The Consulting Center, Horton Social Science Center, UNH Durham, N.H. 03824

Phone: (603) 862-3750

Contact: Dr. James D. Morrison

Additional information

Name: Paul H. Guilderson

Agency: Office of Industrial Development, State of N.H. Department of Resources & Economic Development

Address: Prescott Park, Building Two, 105 Loudon Road, Concord, N.H. 03301

Phone: (603) 271-2591

New Jersey

Business conditions

Percentage of new business started in 1985 in electronics 30%

State/local start-up assistance available for new business . . . . Yes

Number of electronics companies . . . 1,050

Additional information

Name: Ben Ferrara

Agency: New Jersey Department of Commerce, Division of Economic Development

Address: One West State Street, Trenton, N.J. 08625

Phone: (609) 292-7757

New York

Business conditions

Average construction costs (per square foot) . . . . $20-$60

Number of state/local sponsored incubator programs 7

State/local start-up assistance available for new business . . . . Yes

Number of electronics companies . . . 1,472

Additional information

Name: Raymond Paolino

Agency: New York State Department of Commerce

Address: One Commerce Plaza, Albany, N.Y. 12245

Phone: (518) 474-1431

Pennsylvania

Business conditions

Number of state/local sponsored incubator programs 27

Percentage of new business started in 1985 in electronics 3.48%

State/local start-up assistance available for new business . . . . Yes

Number of electronics companies 269

Additional information

Name: Joy Pooler

Agency: Bureau of Domestic Commerce

Address: Forum Building, Room 453, Harrisburg, Pa. 17120

Phone: (717) 787-6500

Rhode Island

Business conditions

Average cost of industrial land (per acre) $40,000

Average construction costs (per square foot) $35

Number of state/local sponsored incubator programs 1

State/local start-up assistance available for new business . . . . Yes

Number of electronics companies . . . . . N/A

Additional information

Name: James Hagan

Agency: Rhode Island Department of Economic Development

Address: 7 Jackson Walkway, Providence, R.I. 02903

Phone: (401) 277-2601

Vermont

Business conditions

Average cost of industrial land (per acre) $15,300

Average construction costs (per square foot) $23

State/local start-up assistance available for new business . . . . Yes

Number of electronics companies 36

Educational facilities

Number of four-year colleges and universities 12

Additional information

Name: Fred Newhall

Agency: Vermont Economic Development Department

Address: 109 State Street, Montpelier, Vt. 05602

Phone: (802) 828-3221

Atlantic

Delaware

Business conditions

Average cost of industrial land (per acre) $20,000

Average construction costs (per square foot) $23

State/local start-up assistance available for new business . . . . Yes

Number of electronics companies 11

Educational facilities

Number of four-year colleges and universities 6

Industrial parks with university affiliations:

Industrial park: University of Delaware Office/Research Park - Stanton

University affiliation: University of Delaware

Address: Route 4 and Churchman's Road, I-95, Stanton, Del. 19804

Phone: (302) 645-4251

Contact: George Claypoole

Industrial park: University of Delaware Research Park - Lewes
University affiliation: University of Delaware
Address: New Road, Lewes, Del. 19958
Phone: (302) 645-4251
Contact: George Claypoole

Additional information

Name: Louis H. Papineau Jr.
Agency: Delaware Development Office
Address: 99 Kings Highway, P.O. Box 1401, Dover, Del. 19903
Phone: (302) 736-4271

Florida

Business conditions

Average cost of industrial land (per acre) . . . .$10,000-$48,000
Average construction costs (per square foot). . . . .$15-$19
Number of state/local sponsored incubator programs 2
Percentage of new business started in 1985 in electronics 18
State/local start-up assistance available for new business . . . . .Yes
Number of electronics companies 465

Educational facilities

Number of four-year colleges and universities. 104
Industrial parks with university affiliations:
Industrial park: Biomedical Research and Innovation Center
University affiliation: Florida International University, University of Florida
Address: College of Engineering, Tamiami Campus, Florida International University, Miami, Fla. 33199
Phone: (305) 554-2521
Contact: Gordon Hopkins
Industrial park: Central Florida Research Park
University affiliation: University of Central Florida
Address: 11800 Research Parkway, Orlando, Fla. 32826
Phone: (305) 282-3944
Contact: Patrick Baughn
Industrial park: First Coast Technology Park
University affiliation: University of North Florida
Address: P.O. Box 17074, Jacksonville, Fla. 32216
Phone: (904) 646-2487
Contact: Will Ingram
Industrial park: Florida Atlantic Research and Development Authority
University affiliation: Florida Atlantic University
Address: Academic Affairs, Florida Atlantic University, Boca Raton, Fla. 33431
Phone: (305) 393-3068
Contact: Jeff Tennant
Industrial park: Innovation Park
University affiliation: Florida State University, Florida A&M University
Address: 1673 W. Paul Dirac Drive, Tallahassee, Fla. 32304
Phone: (904) 575-6381
Contact: W.T. Gaupin
Industrial park: Interstate Business Park
University affiliation: Fort Lauderdale University
Address: 8402 Laurel Fair Circle, Suite 100, Tampa, Fla. 33610
Phone: (813) 623-6511
Contact: Jeff Griffith
Industrial park: Progress Center
University affiliation: University of Florida
Address: One Progress Boulevard, Alachua, Fla. 32615
Phone: (904) 462-4040
Contact: Sandra Burgess
Industrial park: Tampa Bay Area Research and Development Park
University affiliation: University of South Florida
Address: Administration Building, Room 280, University of South Florida, 4202 Fowler Avenue, Tampa, Fla. 33620
Phone: (813) 974-2890
Contact: Gen. Jack Hennessey
Industrial park: Tampa Technology Park
University affiliation: University of South Florida
Address: 201 East Kennedy Boulevard, Suite 1539, Tampa, Fla. 33602
Phone: (813) 229-3462
Contact: Dave Tyler

Additional information

Name: Steve Mayberry
Agency: Florida Division of Economic Development
Address: 501 B Collins Building, 107 W. Gaines Street, Tallahassee, Fla. 32301
Phone: (904) 488-6300

Georgia

Additional information

Name: Director
Agency: Industry and Trade Department
Address: 1400 North Omni International, Atlanta, Ga. 30303
Phone: (404) 656-2245

Maryland

Business conditions

Average cost of industrial land (per acre) . . . .$9,000-$90,000
Average construction costs (per square foot) . . . .$2-$7
Number of state/local sponsored incubator programs 1
Number of electronics companies . . .1,100

Educational facilities

Number of four-year colleges and universities. 35
Industrial parks with university affiliations:
Industrial park: Maryland Science and Technology Center
University affiliation: University of Maryland
Address: Bowie, Md.
Industrial park: Shady Grove Life Sciences Center
University affiliation: Johns Hopkins University
Address: Rockville, Md.

Additional information

Name: Michael S. Lofton
Agency: Office of Business and Industrial Development, Department of Economic and Community Development
Address: 45 Calvert Street, Annapolis, Md. 21401
Phone: (301) 269-3566

North Carolina

Business conditions

Average construction costs (per square foot) $27
Number of state/local sponsored incubator programs 6
Percentage of new business started in 1985 in electronics 26.9%
State/local start-up assistance available for new business . . . . .Yes
Number of electronics companies 285

Educational facilities

Number of four-year colleges and universities. 30
Industrial parks with university affiliations:
Industrial park: Research Triangle Park
University affiliation: Duke University, North Carolina State University, University of North Carolina at Chapel Hill
Address: P.O. Box 12255, Research Triangle Park, N.C. 27709
Phone: (919) 549-8181
Contact: Robert E. Leak
Industrial park: University Research Park in Charlotte
University affiliation: University of North Carolina at Charlotte
Address: 2400 First Union Plaza, Charlotte, N.C.
Phone: (704) 375-6220
Contact: Seddon Goode Jr.

Additional information

Name: Robert Brinkley
Agency: North Carolina Department of Commerce
Address: 430 N. Salisbury Street, Raleigh, N.C. 27611
Phone: (919) 733-4151

South Carolina

Additional information

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Phone: (803) 758-3351

Virginia

Additional information

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Agency: Economic Development Department

Address: Washington Building, Richmond, Va. 23219

Phone: (804) 786-6430

West Virginia

Business conditions

Average cost of industrial land (per acre)	$20,000
Average construction costs (per square foot)	$18
Number of state/local sponsored incubator programs	3
Percentage of new business started in 1985 in electronics	12.5%
State/local start-up assistance available for new business	Yes
Number of electronics companies	31

Educational facilities

Industrial parks with university affiliations:

Industrial park: Morgantown Industrial Park

University affiliation: West Virginia University

Address: 1000 Dupont Road, Building 510, Morgantown, W. Va. 26505

Phone: (304) 292-9453

Contact: John R. Snider

Additional information

Name: Lysander L. Dudley Sr.

Agency: Governer's Office of Community and Industrial Development

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Phone: (304) 348-0400

South

Alabama

Additional information

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Address: 1445 Federal Drive, Montgomery, Ala. 36109

Phone: (205) 261-2650

Arkansas

Additional information

Name: Cathy Davidson

Agency: State Data Center/Research and Public Service

Address: University of Arkansas, 33rd and University, Little Rock, Ark. 72204

Phone: (501) 371-1973

Kentucky

Business conditions

Average construction costs (per square foot)	$20
Number of state/local sponsored incubator programs	2
Percentage of new business started in 1985 in electronics	N/A
State/local start-up assistance available for new business	Yes
Number of electronics companies	55

Educational facilities

Number of four-year colleges and universities	25

Additional information

Name: Carroll Knicely

Agency: Kentucky Commerce Cabinet

Address: 2400 Capital Plaza Tower, Frankfort, Ky. 40601

Phone: (502) 564-7670

Louisiana

Business conditions

Average construction costs (per square foot)	$23
State/local start-up assistance available for new business	Yes
Number of electronics companies	91

Educational facilities

Number of four-year colleges and universities	17

Additional information

Name: Dave Bowman

Agency: Louisiana Department of Commerce

Address: Box 94185, Baton Rouge, La.

Phone: (504) 342-5405

Mississippi

Business conditions

Average construction costs (per square foot)	$11
Number of state/local sponsored incubator programs	None
Percentage of new business started in 1985 in electronics	4%
State/local start-up assistance available for new business	Yes
Number of electronics companies	22

Educational facilities

Number of four-year colleges and universities	16

Industrial parks with university affiliations:

Industrial park: Mississippi Research and Technology Park

University affiliation: Mississippi State University

Address: 322 University Drive, Starkville, Miss. 39759

Phone: (601) 323-5783

Contact: Mike Clayborne

Additional information

Name: Jerry McDonald

Agency: Mississippi Department of Economic Development

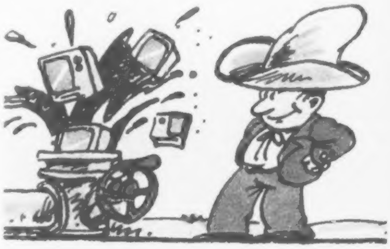
Address: 1201 Sillers Building, 500 High Street, Jackson, Miss. 32901

Phone: (601) 354-7011

Oklahoma

Business conditions

Average construction costs (per square foot)	$32
Percentage of new business started in 1985 in electronics	14%
State/local start-up assistance available for new business	Yes
Number of electronics companies	164



Educational facilities

Number of four-year colleges and universities	164

Additional information

Name: Grover Phillips

Agency: Industrial Division, Department of Commerce

Address: 6601 Broadway Extension, Oklahoma City, Okla. 73116

Phone: (405) 521-2401

Tennessee

Business conditions

Average cost of industrial land (per acre)	$5,000-$25,000
Average construction costs (per square foot)	$2.77-$3.35
Number of state/local sponsored incubator programs	2
Percentage of new business started in 1985 in electronics	5.9%
Number of electronics companies	275

Educational facilities

Number of four-year colleges and universities	37

Industrial parks with university affiliations:

Industrial park: Tennessee Technology Corridor

University affiliation: University of Tennessee

Address: P.O. Box 23184, Knoxville, Tenn. 37933

Phone: (615) 966-2804
Contact: Dr. David A. Patterson

Additional information

Name: John M. Crothers
Agency: State of Tennessee Department of Economic and Community Development
Address: Rachel Jackson Building, 6th floor, Nashville, Tenn. 37219
Phone: (615) 741-2994

Texas

Business conditions

Average cost of industrial land (per acre) .... $20,000-$112,400
Average construction costs (per square foot) $46
Percentage of new business started in 1985 in electronics 3.5%
State/local start-up assistance available for new business .... Yes
Number of electronics companies 4,926

Educational facilities

Number of four-year colleges and universities 136
Industrial parks with university affiliations:
Industrial park: Texas A&M University Research Park
University affiliation: Texas A&M University
Address: College Station, Texas 77843
Phone: (409) 845-7275
Contact: Mark Mooney or John Millhollon
Industrial park: River Bend Industrial Park
University affiliation: Advanced Robotics Research Institute
Address: 2501 Gravel Drive, Fort Worth, Texas 76118
Phone: (817) 589-2200
Contact: Jack Frederick

Additional information

Name: Jack Alexander
Agency: Texas Economic Development Commission
Address: P.O. Box 12728, Capitol Station, Austin, Texas 78711
Phone: (512) 472-5059

Midwest

Illinois

Business conditions

Average cost of industrial land (per acre) $5,000
Average construction costs (per square foot) $30
Number of state/local sponsored incubator programs 16
Percentage of new business started in 1985 in electronics 13%
State/local start-up assistance available for new business .... Yes
Number of electronics companies 992

Educational facilities

Number of four-year colleges and universities 179
Industrial parks with university affiliations:
Industrial park: Evanston-University Research Park
University affiliation: Northwestern University
Address: 2100 Ridge Avenue, Evanston, Ill. 60204
Phone: (312) 866-2936
Contact: Judith Aiello

Additional information

Name: Sharon Sharp
Agency: Department of Commerce and Community Affairs
Address: State of Illinois Center, 100 W. Randolph, Suite 3-400, Chicago, Ill. 60601
Phone: (312) 917-6306

Indiana

Business conditions

Number of state/local sponsored incubator programs 5

Percentage of new business started in 1985 in electronics 10%
State/local start-up assistance available for new business .... Yes
Number of electronics companies 99

Educational facilities

Number of four-year colleges and universities 65
Industrial parks with university affiliations:
Industrial park: Purdue Industrial Research Park
University affiliation: Purdue University
Address: Hovde Hall, West Lafayette, Ind. 47907
Phone: (317) 494-8642
Contact: Winfield F. Hentshel
Industrial park: Indiana University Research Park
University affiliation: Indiana University
Address: 104 Bryan Hall, Bloomington, Ind.
Phone: (812) 335-8913
Contact: Dr. Morton Lowengrub
Industrial park: Aleph Park
University affiliation: Indiana State University & Rose Hulman University
Address: 200 W. Campus Drive, Terre Haute, Ind. 47802
Phone: (812) 232-2208
Contact: Joseph Steele

Additional information

Name: Mark Akers
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Address: One North Capitol Plaza, Suite 700, Indianapolis, Ind. 46204-2288
Phone: (317) 232-8888

Iowa

Additional information

Name: Craig Hamilton
Agency: Iowa Development Commission
Address: 600 E. Court Street, Des Moines, Iowa 50309
Phone: (515) 281-5979

Kansas

Business conditions

Average cost of industrial land (per acre) $30,000
Average construction costs (per square foot) $55
Percentage of new business started in 1985 in electronics 10%
State/local start-up assistance available for new business .... Yes
Number of electronics companies 146

Educational facilities

Industrial park: University Corporate Research Park
University affiliation: University of Kansas
Address: P.O. Box 581, 823 Vermont, Lawrence, Kan. 66044
Phone: (913) 843-4411
Contact: William A. Martin
Industrial park: Foundation Techni-Park
University affiliation: Kansas State University
Address: P.O. Box 988, 505 Poyntz Avenue, Manhatten, Kan. 66502
Phone: (913) 776-8829
Contact: Mike Hauser
Industrial park: Comotara Industrial Park
University affiliation: Wichita State University
Address: 350 W. Douglas, Wichita, Kan.
Phone: (316) 265-7771
Contact: Ed Roberts

Additional information

Name: Bill Thompson
Agency: Kansas Department of Economic Development
Address: 400 W. 8th Street, Capitol Towers, Topeka, Kan. 66603
Phone: (913) 296-3483

Michigan

Business conditions

Average cost of industrial land (per acre) .... $3,000-$100,000
Average construction costs (per square foot) $127
Number of state/local sponsored incubator programs 20
State/local start-up assistance available for new business .... Yes
Number of electronics companies 462

Educational facilities

Number of four-year colleges and universities 15

Industrial parks with university affiliations:

Industrial park: Huron Center
University affiliation: Eastern Michigan State University
Address: Ypsilanti Township, Mich. 48197
Phone: (313) 761-9317
Contact: Mike Amman

Industrial park: Superior Technology Park
University affiliation: University of Michigan
Address: Superior Township, Mich. 48104
Phone: (313) 761-9317
Contact: Mike Amman

Industrial park: Ann Arbor Technology Park
University affiliation: University of Michigan
Address: Ann Arbor Township, Mich. 48106
Phone: (313) 761-9317
Contact: Mike Amman

Industrial park: Hannah Technology and Research Center
University affiliation: Michigan State University
Address: East Lansing, Mich. 48823
Phone: (517) 351-2480
Contact: Eyde Construction Co.

Industrial park: Oakland Technology Park
University affiliation: Oakland University, Oakland County Community College
Address: Auburn Hills, Mich. 48057
Phone: (313) 858-0732
Contact: Jeffery Kaczmarek

Industrial park: University Park
University affiliation: Central Michigan University
Address: Mount Pleasant, Mich. 48858
Phone: (517) 772-2858
Contact: George Dunn

Additional information

Name: Greg Main
Agency: Manufacturing Services
Address: P.O. Box 30225, Lansing, Mich. 48909
Phone: (517) 373-3550

Minnesota

Additional information

Name: Harry Rosefelt
Agency: Department of Energy and Economic Resources
Address: 900 American Center Building, 150 E. Kellogg Boulevard, St. Paul, Minn. 55101
Phone: (612) 296-5010

Missouri

Business conditions

Average cost of industrial land (per acre) .... $4,000-$35,000
Average construction costs (per square foot) .... $19-$35
Number of state/local sponsored incubator programs 5
Percentage of new business started in 1985 in electronics 8.5%
State/local start-up assistance available for new business .... Yes
Number of electronics companies 278

Educational facilities

Number of four-year colleges and universities 88

Industrial parks with university affiliations:

Industrial park: The Research Park
University affiliation: University of Missouri-Columbia
Address: University of Missouri, 202 Jesse Hall, Columbia, Mo. 65211
Phone: (314) 882-6311
Contact: Dean Don H. Blunt

Industrial park: Missouri Research Park
University affiliation: University of Missouri-St. Louis
Address: University of Missouri, 225 University Hall, Columbia, Mo. 65211
Phone: (314) 882-6311
Contact: L. Thomas Hussey

Industrial park: UMKC North Campus Development Project
University affiliation: University of Missouri-Kansas City
Address: University of Missouri, 225 University Hall, Columbia, Mo. 65211
Phone: (314) 882-6311
Contact: L. Thomas Hussey

Additional information

Name: Ed Martin
Agency: Missouri Department of Economic Development
Address: P.O. Box 118, Jefferson City, Mo. 65102
Phone: (314) 751-4539

Nebraska

Business conditions

Average cost of industrial land (per acre) .... $0-$152,460
Average construction costs (per square foot) $34
Number of state/local sponsored incubator programs 1
Percentage of new business started in 1985 in electronics 7%
State/local start-up assistance available for new business .... Yes
Number of electronics companies 73

Educational facilities

Number of four-year colleges and universities 19

Additional information

Name: Bob Lewis
Agency: Recruitment Division, Nebraska Department of Economic Development
Address: P.O. Box 94666, Lincoln, Neb. 68509
Phone: (402) 471-3111

North Dakota

Additional information

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Ohio

Additional information

Name: Keith Ewald
Agency: Ohio Data User Center/Development Office
Address: 30 E. Broad Street, 26th floor, P.O. Box 1001, Columbus, Ohio 43266-0101
Phone: (614) 466-2480

South Dakota

Business conditions

Average cost of industrial land (per acre) $10,000
Average construction costs (per square foot) .... $17-$22
Number of state/local sponsored incubator programs 1
Percentage of new business started in 1985 in electronics 18%
Number of electronics companies 158

Educational facilities

Number of four-year colleges and universities 12

Additional information

Agency: Department of State Development
Address: Capitol Lake Plaza, P.O. Box 6000, Pierre, S.D. 57501
Phone: 605-773-5032

Wisconsin

Business conditions

Average cost of industrial land (per acre) $6,000
Average construction costs (per square foot) .... $18-$50
Number of state/local sponsored incubator programs 6
Percentage of new business started in 1985 in electronics 6%
State/local start-up assistance available for new business .... Yes
Number of electronics companies 345

Educational facilities

Number of four-year colleges and universities 42

Industrial parks with university affiliations:

Industrial park: University Research Park
University affiliation: University of Wisconsin-Madison
Address: 945 WARF Building, 610 Walnut Street, Madison, Wis.
Phone: (608) 238-8670
Contact: Wayne McGown

Additional information
Name: Rolf Wegenke
Agency: State of Wisconsin Department of Development, Division of Economic and Community Development
Address: State Justice Building, P.O. Box 7970, 123 W. Washington Avenue, Madison, Wis. 53707
Phone: (608) 266-3203

Mountain

Arizona

Business conditions

Average construction costs (per square foot) $25
Number of state/local sponsored incubator programs .... None
Percentage of new business started in 1985 in electronics 4%
State/local start-up assistance available for new business .... Yes
Number of electronics companies 280

Educational facilities

Number of four-year colleges and universities 19
Industrial parks with university affiliations:
Industrial park: Arizona State University Research Park
University affiliation: Arizona State University
Address: 2105 E. Elliott Road, Tempe, Ariz. 85284
Phone: (602) 965-2105
Contact: Reginald W. Owens

Additional information

Name: Janice M. Schaefer
Agency: Arizona Department of Commerce
Address: 1700 West Washington, Phoenix, Ariz. 85007
Phone: (602) 255-5374

Colorado

Additional information

Name: Steve Schmidt
Agency: Commerce and Development Division
Address: 1313 Sherman Street, Room 523, Denver, Colo. 80203
Phone: (303) 866-5491

Idaho

Business conditions

Average cost of industrial land (per acre) $45,000
Average construction costs (per square foot) $50
Number of state/local sponsored incubator programs 5
Percentage of new business started in 1985 in electronics 3.3%
State/local start-up assistance available for new business .... Yes
Number of electronics companies 62

Educational facilities

Number of four-year colleges and universities 6
Industrial parks with university affiliations:
Industrial park: ISU Research and Business Park
University affiliation: Idaho State University
Address: P.O. Box 8044, Pocatello, Idaho 83209
Phone: (208) 236-2430
Contact: Dr. Les Purce
Industrial park: Simplot-Micron Technology Center
University affiliation: Boise State University
Address: 1910 University Drive, Boise, Idaho 83725
Phone: (208) 385-3289
Contact: Ben Hambelton

Additional information

Name: Jay Engstrom
Agency: Department of Commerce
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Montana

Additional information

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Nevada

Additional information

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Agency: Commission of Economic Development
Address: Capitol Complex, 600 E. Williams, Suite 203, Carson City, Nev. 98701
Phone: (702) 885-4325

New Mexico

Business conditions

Number of electronics companies 30

Educational facilities

Number of four-year colleges and universities 2

Additional information

Name: Terry Allbrooks
Agency: Albuquerque Economic Development Inc.

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Utah

Business conditions

Average cost of industrial land (per acre) $75,000
Average construction costs (per square foot) .... $21-$38
State/local start-up assistance available for new business .... Yes
Number of electronics companies 260

Educational facilities

Number of four-year colleges and universities 4
Industrial parks with university affiliations:
Industrial park: University of Utah Research Park
University affiliation: University of Utah
Address: 391 Chipeta Way, Salt Lake City, Utah 84108
Phone: (801) 581-8133

Additional information

Name: Howard Bird
Agency: Department of Community and Economic Development
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Phone: (801) 533-5325

Wyoming

Additional information

Name: John Logan
Agency: Economic Development and Stabilization Board
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Phone: (307) 777-7284

Pacific

Alaska

Additional information

Name: Paul Fletcher
Agency: Department of Commerce Office of Enterprise
Address: State Office Building, Pouch D, Juneau, Alaska 99811
Phone: (907) 465-2018

California

Business conditions

Average construction costs (per square foot): $50

Educational facilities

Number of four-year colleges and universities: 328

Additional information

Name: Don Backstrom
Agency: Industrial Development Financial Advisory Commission
Address: 915 Capitol Mall, Room 280, Sacramento, Calif. 95814
Phone: (916) 445-9597

Hawaii

Additional information

Name: Cornelius Downes
Agency: Planning and Economic Development Department
Address: 250 South King Street, 7th floor, Honolulu, Hawaii 96804
Phone: (808) 548-4620

Oregon

Business conditions

Average cost of industrial land (per acre) .... $5,000-$85,000
Average construction costs (per square foot) .... $0.18-$0.75

Number of state/local sponsored incubator programs 4
State/local start-up assistance available for new business .... Yes
Number of electronics companies 368

Educational facilities

Number of four-year colleges and universities 27
Industrial parks with university affiliations:
Industrial park: Oregon Graduate Center Science Park
University affiliation: Oregon Graduate Center
Address: 1600 N.W. Compton Drive, Suite 300, Beaverton, Ore. 97006
Phone: (503) 690-1121
Contact: Dr. F. Paul Carlson

Additional information

Name: Thomas F. Kennedy
Agency: Oregon Economic Development Department
Address: 595 Cottage Street N.E., Salem, Ore. 97310
Phone: (503) 373-1200, 1-800-547-7842

Washington

Additional information

Name: John Anderson
Agency: Commerce and Economic Development Department
Address: General Administration Building, Olympia, Wash. 98504
Phone: (206) 753-7426

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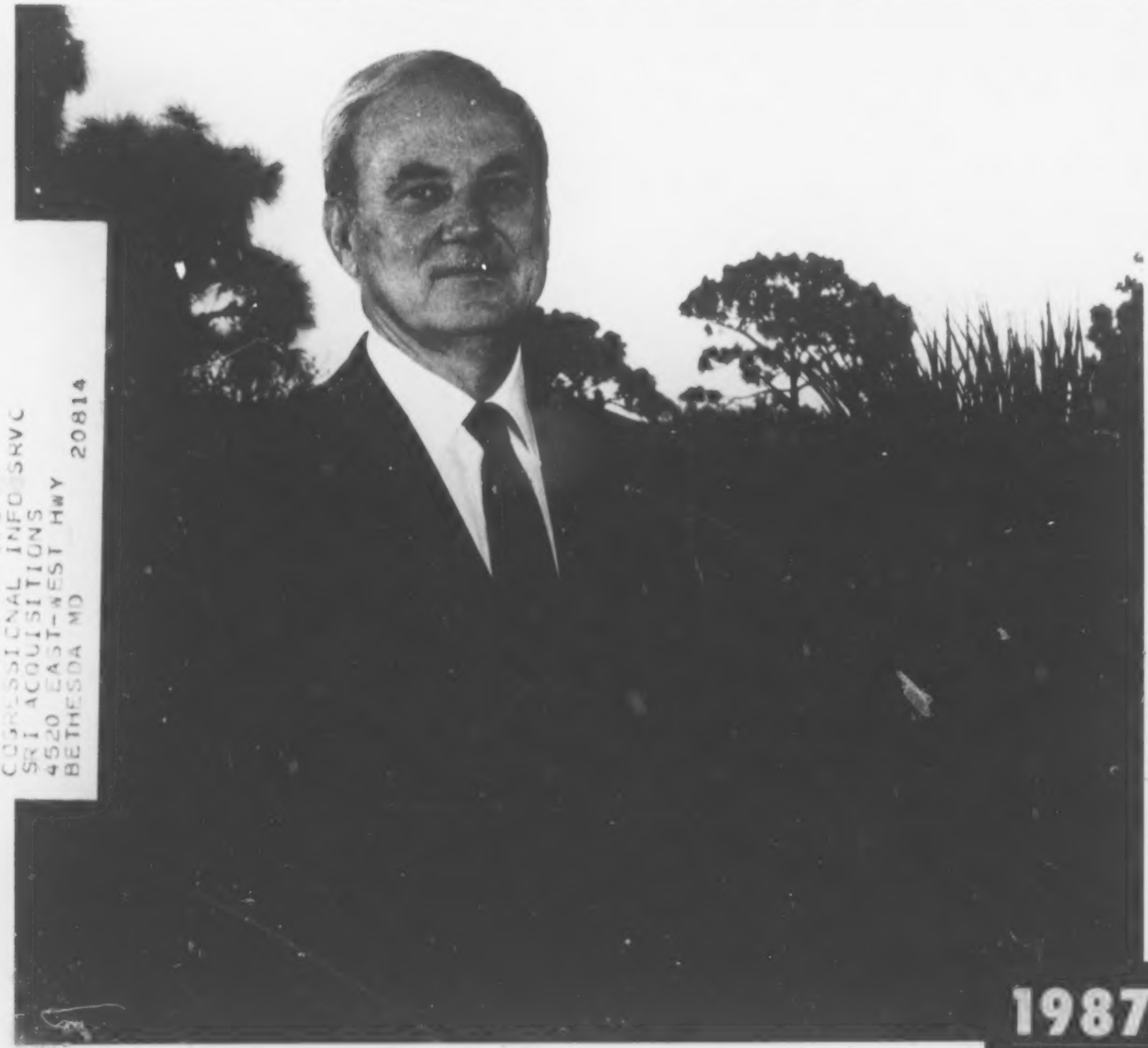

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John T. Hartley: The new force at Harris

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DECEMBER 10, 1986

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Cover photo/Greg Leary

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BPA ABP

Fujitsu plus Fairchild: hope for profits and more ASICs

The summer was sunny for semiconductor sales in dollars, but not in yen

Fujitsu Ltd.'s investment in — and proposed acquisition of — Fairchild Semiconductor Corp. summarizes the status of the semiconductor market: the yen's jump, the profits' crunch and the ASIC's growth. In Japan, Fujitsu's homeground, revenue in yen has declined much faster than expenses. Japanese chip makers, then, have followed their American counterparts in reporting red ink for 1986. Fujitsu already is the second largest supplier of metal-oxide semiconductor (MOS) gate arrays, the largest segment of the application-specific integrated circuits market, and Fairchild has a good position in emitter-coupled logic (ECL) gate arrays for military applications.

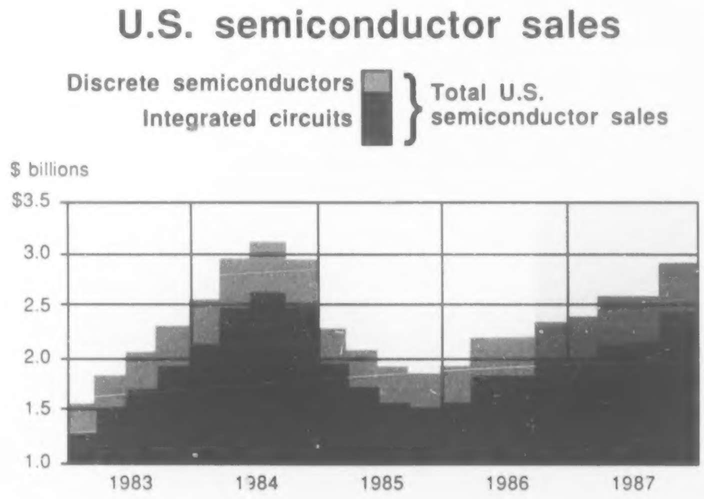
But just as the Japanese market for semiconductors has slowed its growth in dollars (while declining in yen), the U.S. market is picking up. Shipments to U.S. customers in the third quarter of 1986 exceeded last year's by 16%. Moreover, the summer months notwithstanding, third quarter shipments held even with respect to the previous quarter's shipments, which, in turn, were the highest since the first quarter of 1985. This is a good performance; it shows a slow but steady growth.

Cahners Economics expects growth to continue. It forecasts a fourth quarter strong enough to push 1986 U.S. shipments past 1985's by 6% to 7%. Jack Beedle of In-Stat, a market researcher who specializes in semiconductors, believes it is too late into the year to come up with anything more than 4% growth. Another semiconductor market specialist, Integrated Circuit Engineering Corp., is in the middle at 6%.

In-Stat's vice president of operations, Jim Feldham, deduces that Fujitsu's move is prompted by the attractiveness of the ASICs market in the United States. The figures support his assertion, because sales by companies that are in the ASICs market have grown much faster than for other semiconductors. For example, Intel Corp., which only recently entered the gate arrays market through an arrangement with IBM, saw its sales grow by only 4% in the third quarter of 1986. Motorola Semiconductor Products Inc., a very broad-based producer of semis, did better than all other large competitors with 21% growth. By contrast, sales by LSI Logic, the leading manufacturer of gate arrays, increased in the third quarter by 34% over last year.

The Semiconductor Industry Association's U.S. book-to-bill ratio for MOS and CMOS ICs, which is strongly influenced by demand for ASICs, had reached 1.16 and 1.20 respectively at midyear and continued to improve in the second half, promising sustained growth for shipments. For all semis, the U.S. book-to-bill ratio turned up in September after declining during the summer. This has encouraged Cahners to forecast 20% growth for 1987. In-Stat says only 6%.

ALBERTO SOCOLOVSKY



Historical data: Semiconductor Industry Association
Forecast: Cahners Economics

Slower growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, showed a mild decline in the second quarter, followed by a slight recovery in the third quarter. For the year, production is expected to be up a scant 0.9% from last year. Next year, steady improvements are forecast thoughout the year pushing production up 3.9% in 1987.

The Cahners Early Warning Indicator (CEWI) is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index. It forecasts probable business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 100.3 level forecasts using the CEWI for the end of this year indicates that the average for all of 1986 should be 0.9% above 1985.

Readers can obtain a brochure explaining the CEWI method from Cheryl Patstone, economist, Cahners Economics Department, 3021 Tisch Way, Suite 100, San Jose, Calif. 95128.

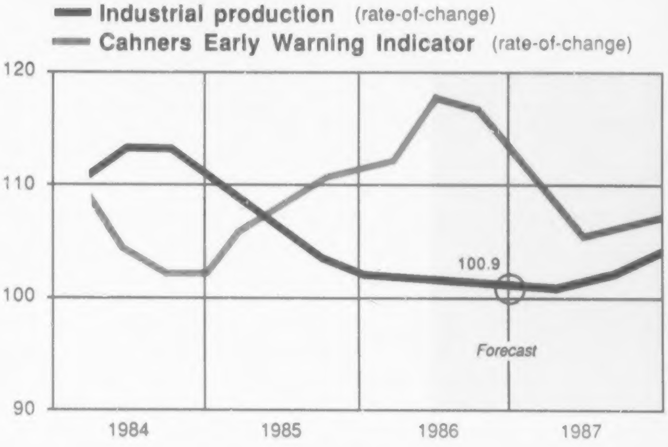
Defense and space equipment

Government spending constraints have begun to curtail the performance of the defense and space industries. Although production of such equipment rose steadily during the first nine months of this year, there was a large decrease in the industry's underlying rate of year-to-year growth. It has hovered in a range of 5% to 5.5% since June, down from about 9.5% at the start of 1986. High order backlogs will enable manufacturers to maintain the current growth rate for several more months, but another cooling off period after mid-1987 is expected. Look for production to post an overall gain of 5.6% this year, 2.8% next year and just 0.5% in 1988.

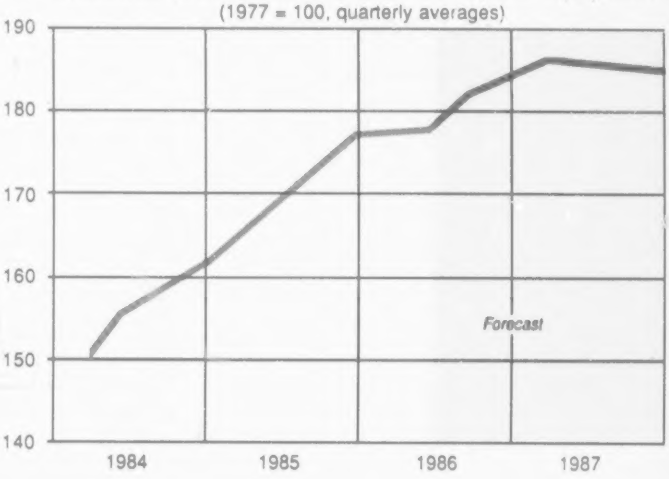
Aircraft and parts

Aircraft manufacturers boosted their production levels by 2.0% in the second quarter. This was a healthy pace of increase but was down nearly a full percentage point from the previous quarter. Preliminary reports for the third quarter point to another gain on the order of 2%. If this occurs, then manufacturing activity for the first nine months of 1986 will have exceeded the year-ago pace by a sizable 12.9% margin. Defense budget cuts are still expected to reduce the industry's growth performance in the late 1980s. After a gain of 11.9% (in real terms) this year, production is expected to rise 4.1% in 1987 and then dip 1% or 2% in 1988.

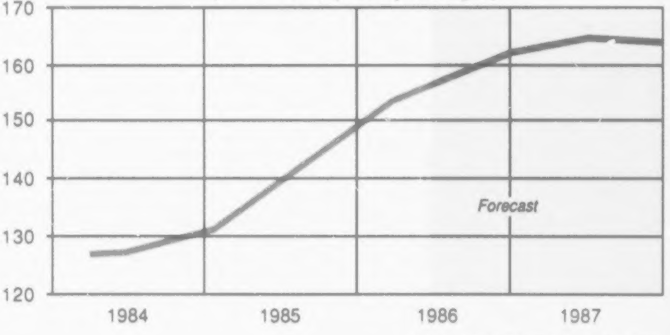
Economic indicators



Industrial production: Defense and space equipment
(1977 = 100, quarterly averages)



Industrial production: Aircraft and parts
(1977 = 100, quarterly averages)



Historical data: Federal Reserve Board
Forecast: Cahners Economics

New orders

Manufacturers of computers and office machines received $11.85 billion in orders in the second quarter of 1986, up from $10.23 billion in the prior quarter. But total first half orders still show a shortfall of nearly 24% from a year earlier. Declines in U.S. industrial growth and concerns over tax reform were largely responsible for this weakness, prompting buyers to postpone all but the most necessary equipment purchases. Orders should pick up somewhat in the second half, which is typically the strongest selling season. However, the negative effects of tax changes will prevent substantial improvements from occurring until at least the middle of next year. Following an overall loss of 10.4% to $48.5 billion in 1986, orders are expected to rebound 15.3% in 1987 and 16.4% in 1988.

Shipments

Shipments were valued at approximately $12.31 billion in this year's second quarter, a gain of 16.8% over the first quarter's pace. However, preliminary reports for the third quarter point to a leveling off in activity and support expectations of disappointing near-term growth. Sluggish U.S. business investment and extremely competitive pricing are expected to dampen the market's performance over the balance of 1986 and into early 1987. This will cause shipments to fall 9.3% to $49.8 billion in the current year. Manufacturers will recoup some of that loss in 1987.

Unfilled orders

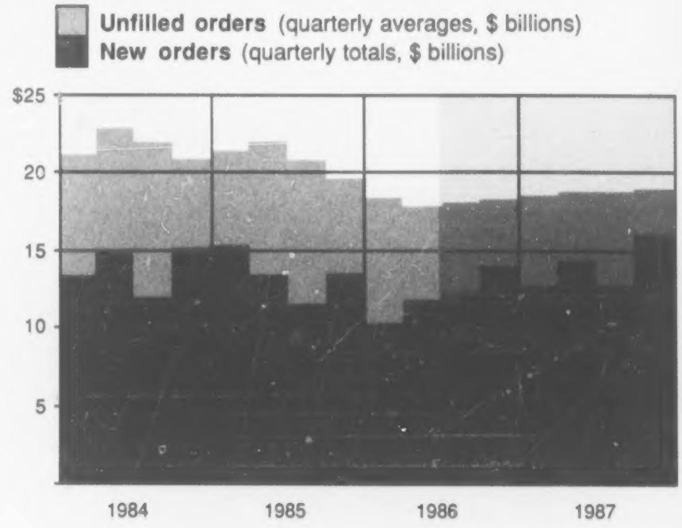
Faced with a long and unusually severe decline in orders, manufacturers of computers and office machines have been drawing down their backlogs almost without interruption since mid-1984. By this June, they had been cut nearly 23% to merely $18 billion (the lowest level in more than three years). Backlogs are expected to stabilize in the second half of this year, but will still show an overall annual loss of 13.5% compared with 1985. Backlogs should edge up about 3.3% in 1987.

Inventory-to-shipment ratio

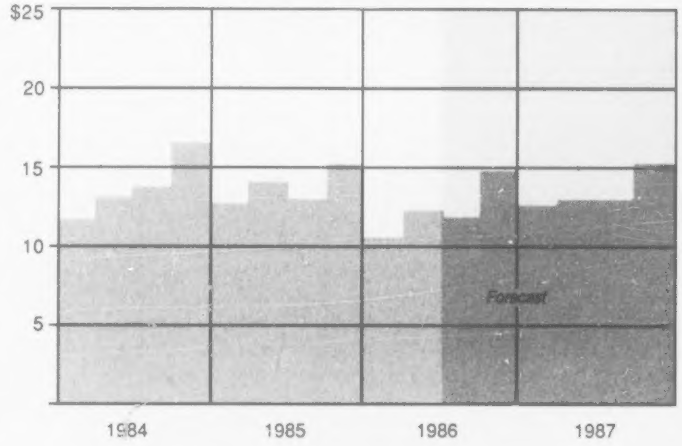
The ratio of industry inventories to shipments (I/S) reached a 10-year high of 3.23 in this year's first quarter, an unusually high level which indicated a need for manufacturers to liquidate inventory. This is precisely what happened in the second quarter; inventories were cut to an average of just $11.5 billion, the lowest level since early 1984 and down approximately 4.4% from the prior quarter. At the same time, shipments showed an increase of 11.7% after seasonal adjustment. These divergent trends drew the industry's I/S ratio back to a more comfortable 2.77 level. The I/S ratio is expected to fluctuate near the current rate for most of the coming year.

Office and computing equipment

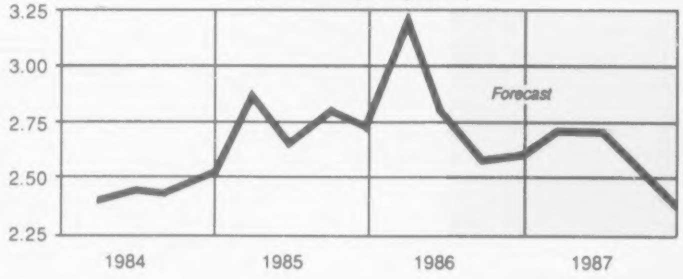
(SIC 357)



Office and computing equipment: Shipments
(quarterly totals, $ billions)



Office and computing equipment: Inventory-to-shipment ratio
(seasonally adjusted)



Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

Communication equipment

(SIC 366)

New orders

New orders for communication equipment fell to $15.43 billion in the second quarter, from $18.81 billion in the first quarter of the year, due almost entirely to a drop in demand for defense-related products. Although cutbacks in defense budget authority will continue to restrain the market's performance over the next several years, overall order activity will be more heavily influenced by trends in the larger nondefense sector. That area has recently shown signs of a slight pickup, and will grow even more rapidly if domestic business investment turns up as expected in late 1987. Following a loss of 3.6% to $67.0 billion in 1986, orders are forecast to increase 6.5% next year and 13.7% in 1988.

Shipments

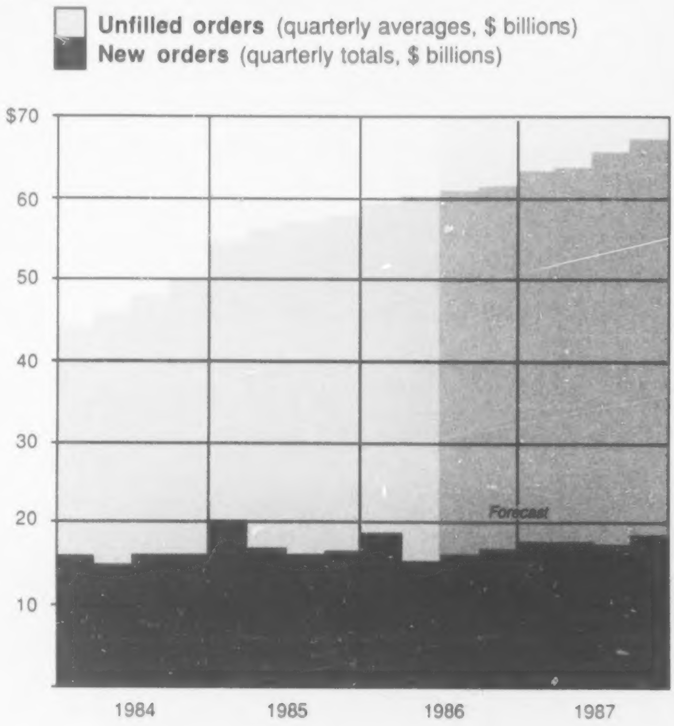
Orders for both defense and nondefense products were sluggish in early 1986, but backlogs in the former area were at a near-record level during the period. This enabled manufacturers to sustain a fairly brisk pace of shipment activity. Shipments reached a second-quarter total of $16.2 billion, an increase of 4.5% over the figure in the first quarter. We expect further gains in the defense area to buoy the industry during late 1986 and early 1987, with a rebound in the nondefense sector causing growth to accelerate after the middle of next year. Shipments will increase 4.8% to $65.5 billion this year, post another modest gain of 5.6% in 1987 and then jump 9.4% in 1988.

Unfilled orders

Manufacturers' backlogs increased slightly in the second quarter, to an average of $60.1 billion from $59.7 billion in the previous three months. But the rise masked a sharp slowdown in the market's underlying rate of growth: backlogs were up just 6.2% on a year-to-year basis in June, less than half of the growth rate which was reported just six months earlier. Sluggish capital spending and a cooling off in the defense sector will cause backlogs to grow just 7.1% this year, the worst performance since 1973. This should be followed by gains of 7.5% and 9.1% in 1987 and 1988, respectively.

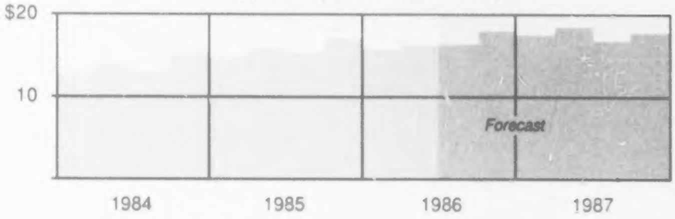
Inventory-to-shipment ratio

The ratio of manufacturers' inventories to shipments continued to climb in the second quarter, reaching an average of 2.87. This was the highest level in 4.5 years, an indication that inventories are probably undesirably high. We expect manufacturers to make some headway against this problem during the next two to three quarters, with more pronounced improvements coming once shipments begin to accelerate in late 1987. The ratio should be down to a more comfortable range of 2.6 to 2.65 by the end of next year.



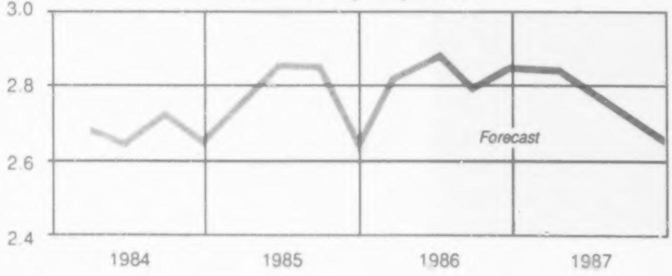
Communication equipment: Shipments

(quarterly totals, $ billions)



Communication equipment: Inventory-to-shipment ratio

(seasonally adjusted)



Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

Competition worries Taiwanese manufacturers

The biggest U.S. exporter of the Orient's four Tiger countries may turn from predator to prey

The idea that Taiwan's $8-billion electronics industry faces any problems would prompt a hollow laugh from many U.S. consumer-electronics gear and computer-periperhal manufacturers being battered by Taiwanese competition.

A look at 1985 international trade statistics would only add to their derision. Taiwan, last year, exported $3.2 billion in electronics to the United States, leading the other three Tiger countries (Hong Kong, Singapore and South Korea) and trailing only Japan in such exports. Last year, its electronics trade notched a surplus of $2.4 billion with the United States and $600 million with Europe. That trade imbalance is expected to widen further by the end of this year as Taiwan's increasingly strong information-products segment grows more sophisticated.

Yet some Taiwan-based executives caution that the country's export-led growth is a fragile success, constantly under threat from mounting protectionism from richer countries and competition from poorer countries keen to "out-Taiwan" Taiwan. These executives fear, too, that the plethora of 2,300 small, mostly family-owned businesses in Taiwan's electronics industry lack the resources to compete in the sophisticated products segment with giant companies from Japan, Korea and the United States.

Says James R. Klein, president of General Instrument of Taiwan Ltd., which manufactures power semiconductors, relays and other components: "In the past [Taiwanese firms] were order takers, with relatively little marketing expertise or brand identification. To move into high technology they will have to invest more and keep on investing more." Adds Hsu Kuo-an, director of the island nation's Industrial Development Board (IDB), "We have manufacturing prowess, not marketing prowess, that's the problem."

The growth of Taiwan's industry over the past decade was fueled by efficient assembly based on productive cheap labor and readily available, cheap investment finance. Large multinational companies built plants to assemble consumer products in volume, while many local enterprises rushed to meet market requirements with low-cost products.

The result is a hotbed of activity today with little regard for tomorrow. A survey done last year by the Council for Economic Planning and Development (CEPD), a Taiwan government agency, shows that the electronics industry consists of 136 companies with collective sales of over $10 million, 60% of these have foreign collaboration. The country has 542 firms with sales of between $1 million and $10 million; and it has over 1,400 firms with sales of less than $1 million.

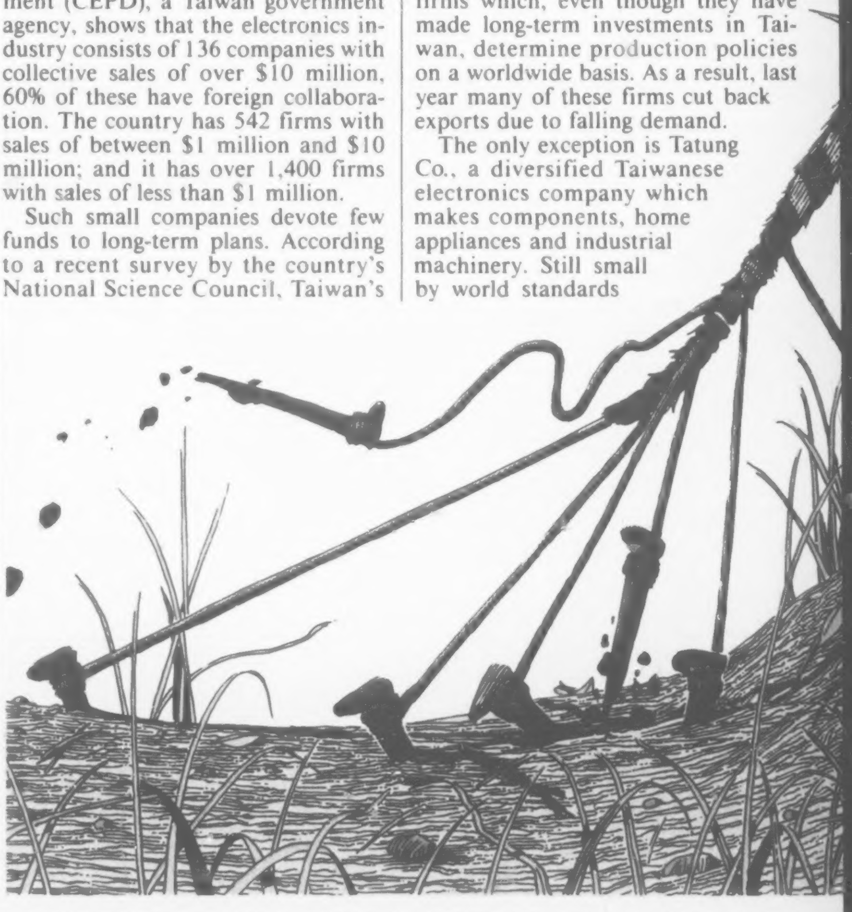
Such small companies devote few funds to long-term plans. According to a recent survey by the country's National Science Council, Taiwan's firms on average spend just 0.44% of sales on research and development — a tiny fraction compared with the industrialized world's percentage spent on R&D.

Concludes Chii-ming Viin, the director responsible for the electronics industry segment of the IDB, "I think a weakness of the electronics industry is that it lacks the big enterprises capable of developing capital-intensive products."

Multinational ambitions

This lack makes Taiwan heavily dependent on foreign-controlled companies. Most of its major electronics exporters are American-managed firms which, even though they have made long-term investments in Taiwan, determine production policies on a worldwide basis. As a result, last year many of these firms cut back exports due to falling demand.

The only exception is Tatung Co., a diversified Taiwanese electronics company which makes components, home appliances and industrial machinery. Still small by world standards

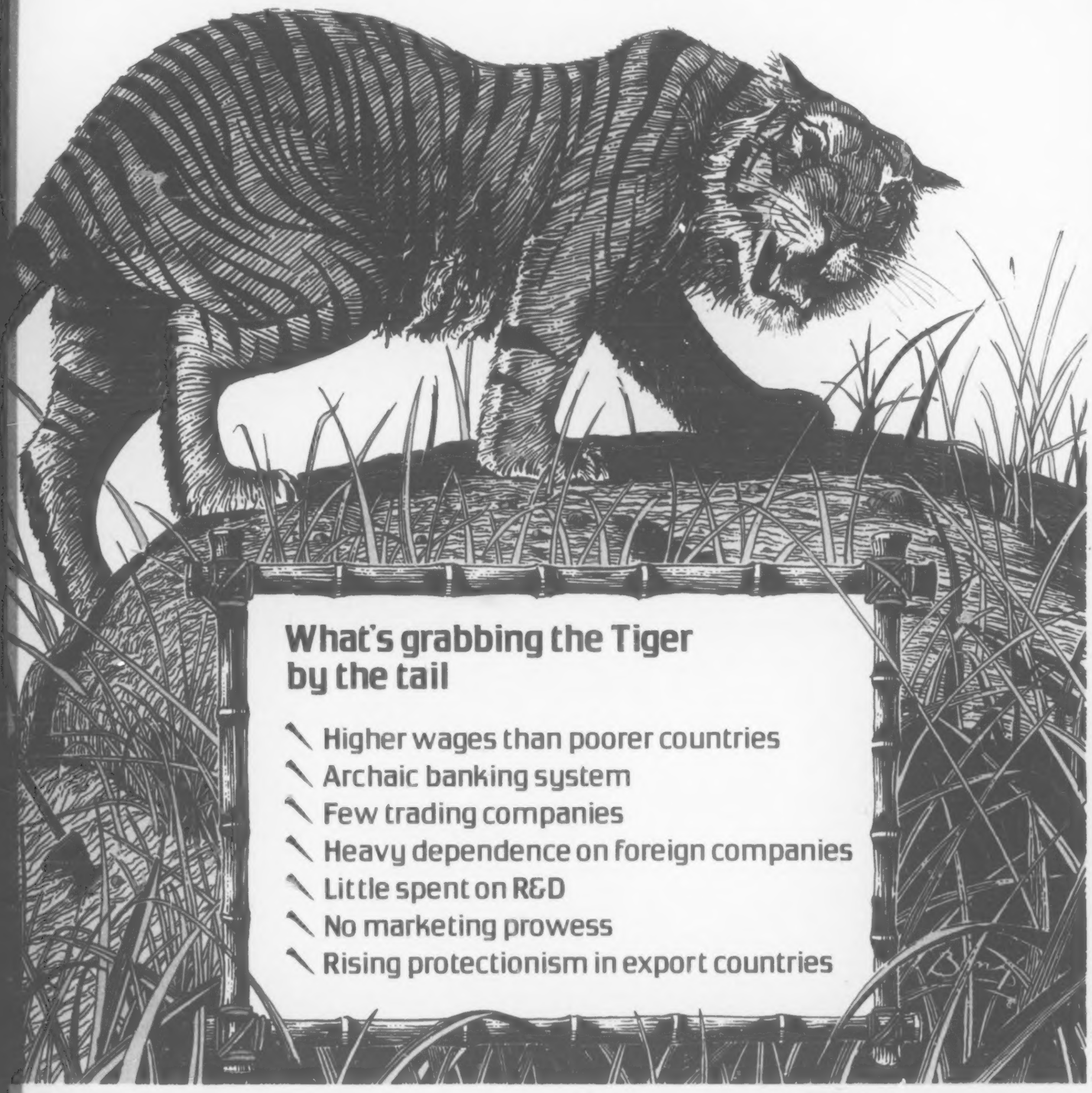


with sales of less than $1 billion last year, it is nevertheless striving to become a true multinational player.

Tatung's general manager for marketing, A.C. Wang, says that his company has boosted its R&D spending from 1% of sales to almost 3% of sales over the last decade. To establish international brand-identity and overcome trade frictions, the firm set up factories to build consumer electronic equipment in Atlanta and Long Beach, Calif., in the 1970s. In 1981, it also established a presence in Great Britian with a factory, now based in Telford, England, capable of building 300,000 color televisions a year, in addition to a range of other consumer products. Says Wang: "Tatung [Britian] will be a good corporate citizen. It will now gradually increase exports from the U.K. to the rest of the European Economic Community."

Another Taiwanese firm aiming to boost its international identity is Multitech Industrial Corp., which recently entered the U.S. business computer market with its IBM PC AT-compatible Accel 900. It is spending $1 million on advertising, and it hopes to sell products worth up to $75 million in the United States this year.

But these two companies are the exceptions. Efforts by the Taiwanese government to promote large-scale trading houses, along the lines of the



What's grabbing the Tiger by the tail

- Higher wages than poorer countries
- Archaic banking system
- Few trading companies
- Heavy dependence on foreign companies
- Little spent on R&D
- No marketing prowess
- Rising protectionism in export countries

Christopher Bing

Japanese model, have so far proved to be largely unsuccessful. As a result, the government is now engaged in a process of persuasion, gentle coercion and exhortation within the domestic manufacturing community to promote innovation and more marketing savvy.

It is a delicate balance. According to Robert H.C. Tsao, president of Taiwan chip maker United Microelectronics Corp. (UMC): "If you take a look at the growth or at the competitive prices it's hard to say there's a problem. Being small makes the firm dynamic."

However, he admits, many sectors of electronics manufacturing, such as integrated circuits (ICs), require additional investment. He says that UMC, Taiwan's first domestic IC fabricator, spends over 20% of sales on capital investment and 10% of sales on R&D. But, he argues, its rapid success and high profitability have been largely due to surging demand by local users, notably in the information products sector, which accounts for 50% of the sales. In the first eight months of 1986, UMC's sales reached $45 million, compared with $35 million for the whole of 1985. Tsao says that UMC has recorded profits of around 25% of sales almost since UMC's first started production in 1982. It is now embarking on a five-year, $150-million project to build a new, 6-inch very large-scale integration (VLSI) wafer-fabrication plant.

IC eloquence

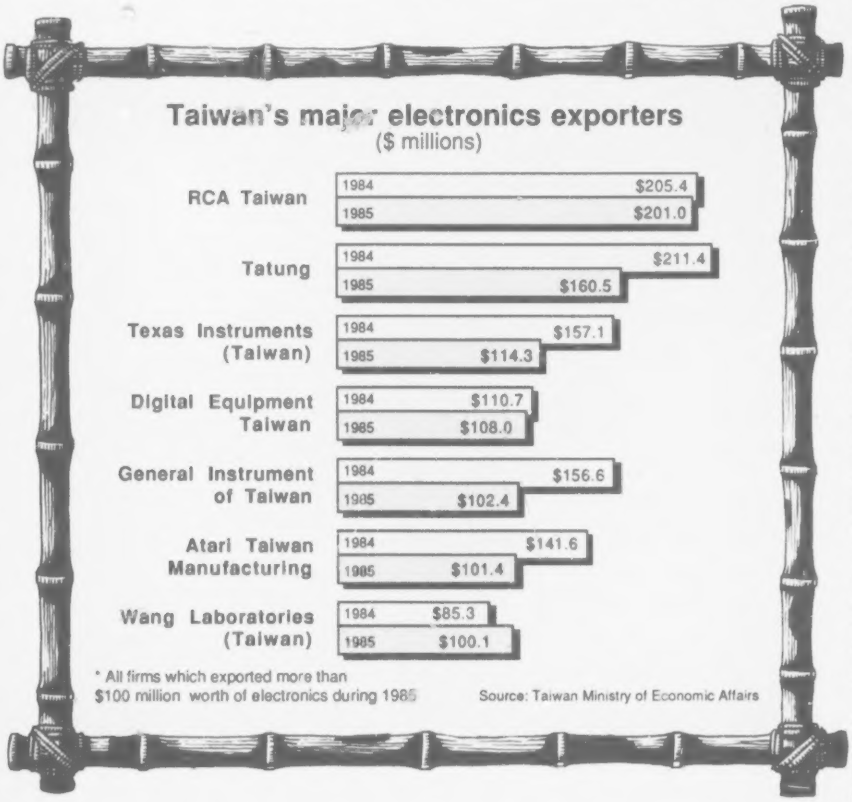
In a way UMC, itself, is an eloquent symbol of the Taiwanese government's approach to industrial planning. Ten years ago, the government set up the Electronics Research and Service Organization (ERSO) and charged it with undertaking fundamental research and setting up a semiconductor fabrication industry. Initially, UMC was partially state-funded via ERSO, but has since been managed as an independent private firm.

Currently ERSO is helping to set up a second IC fabricator — the Taiwan Semiconductor Manufacturing Corp. — in collaboration mainly with Philips, and with Matsushita to a smaller degree.

The government, at present, funds almost half of the electronics R&D, especially through its 2,000-strong research staff at the Industrial Technology Research Institute. ITRI seeks to channel technology to private firms for commercial exploitation.

Also, Taiwan is taking the initiative and is setting up a 5,000-acre science-based industrial park at Hsin-Chu, 70 kilometers south of the capital, Taipei. Over 50 firms have now set up business in the park, although there are still acres of vacant space. Most have been founded by expatriate Chinese professionals who have returned from America. But so far, no Japanese firms have been attracted to Hsin-Chu, which some observers reckon reflects anxiety over the protection of intellectual property rights in Taiwan. To overcome this problem, the Taiwanese Interior Ministry has signed reciprocal copyright pacts with Britain, Spain and the United States and hopes to conclude one with West Germany soon.

But building a science park will not overcome some of the structural problems which will hinder Taiwan's bid to compete in knowledge-intensive industries. To boost R&D spending the government is just setting up a scheme whereby all firms must devote between 0.5% and 1.5% of sales to R&D, depending on the industry involved. Any firm that fails to spend its quota will have to forfeit the difference to the government — which will use it for other R&D. Complains the IDB's Hsu: "We have a very solid foundation of electronics but we lack the R&D."


Taiwan's major electronics exporters
($ millions)

* All firms which exported more than $100 million worth of electronics during 1985

Source: Taiwan Ministry of Economic Affairs

In the bank

Another major problem is Taiwan's archaic banking system. Says one international banker: "Their industry is headed for the 1990s, but their banks are stuck in the 1950s." This is partly because Taiwan's exporters, awash with cash, finance their investments largely through internally generated profits, circumventing the conventional banking system. Consequently, efficient capital markets and industrial financing institutions have been poorly developed. But, now, government-sponsored efforts are under way to ease this problem. The council for Economic Planning and Development has approved a tax-relief plan for investment in high-technology industries, while the Ministry of Finance has approved the formation of six venture capital companies in the last two years in an attempt to mobilize risk capital.

The importation of such policies will be matched by continuing encouragement of direct foreign investment. GI's Klein, who is also chairman of the Asia-Pacific Council of American

Chambers of Commerce, argues that Taiwan offers an unusually open "Welcome Mat" to foreign firms and — unlike many other Asian countries — allows 100% foreign equity ownership and great freedom of operation. Says Klein: "American firms have brought technology in and trained local engineers. There's been a constant spin off of expertise, talent and technology."

Despite this influx, most of the foreign-owned plants in Taiwan are principally assembly operations, which will lose their comparative advantage as Taiwan's labor costs rise relative to other Asian locations' costs.

So the Taiwanese government is using its purchasing leverage to force foreign firms to contribute to Taiwan's national priorities for upgrading technology and boosting exports. An example: It is insisting that the three suppliers of digital public switching equipment — AT&T, GTE and ITT — manufacture, or source, in Taiwan the same value as each of their switching contracts.

Accordingly, the general manager of GTE Communication Systems in Taiwan, Donald C. Blosser, says that GTE has invested $20 million to make its GTD-5 digital exchange in Taiwan and plans to use Taiwan as a base to export other products such as private branch exchanges (PBXs) and telephones to the Asian region.

"Taiwan has a lot going for it," Blosser contends. "Its government is efficient and has managed difficult situations very well. Labor quality is outstanding at all levels, at least on a par with our U.S. staff, and between a third and a quarter of U.S. salaries. There are no financial difficulties at all. We pay an effective interest rate on investment projects of only 6%." Blosser's enthusiasm is echoed by Ken Williams, president of RCA Taiwan, its biggest exporter. "It's a relatively easy place to do business," Williams says. "There's a good investment climate and stable politics."

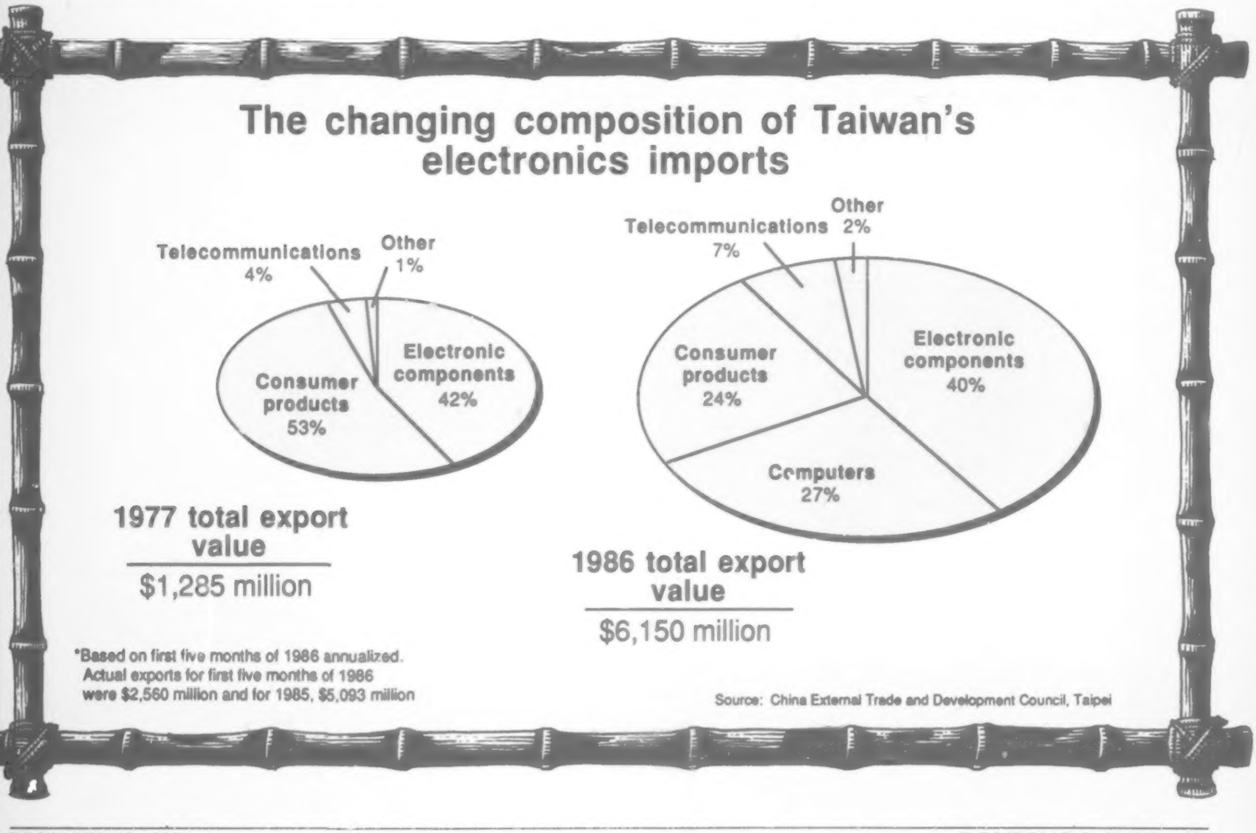
> Most of the foreign-owned plants in Taiwan are principally assembly operations

Sailing up-market

Certainly, Taiwan's first move up-market has been extremely successful. On the basis of its earlier manufacturing technology, learned in making low-cost televisions, it has established itself as a major producer of microcomputers, terminals, monitors and other computer peripherals. Although skeptics point out that most of these products do not possess any more high-technology than the products that preceded them, these products have given Taiwan a major stake in a rapidly growing market.

Taiwan's exports of computer-related products grew from just $114.6 million in 1981 to $1.2 billion in 1985 — including $300 million in monitors, $240 million in microcomputers, $225 million in terminals, $45 million in printers, and $42 million in disk drives. The China External Trade Development Authority predicts computer-related exports will continue to increase sharply and be worth $4.6 billion by 1989. This has already dramatically altered the mix of Taiwan's electronics exports.

This year the trend is continuing. The statistics for the first five months of 1986 show computer exports up 28%; telecommunications exports, 38%; and instrumentation exports, 42%, compared with the same period last year. However, those figures must



The changing composition of Taiwan's electronics imports

*Based on first five months of 1986 annualized. Actual exports for first five months of 1986 were $2,560 million and for 1985, $5,093 million

Source: China External Trade and Development Council, Taipei be tempered by exports of Taiwan's two traditional product strengths — consumer products and components each fell by around 2%.

Moreover there is one black cloud hanging over all the long-term hopes: the risk of protectionism in the United States, which accounts for almost 60% of Taiwan's electronics exports. Taiwan is now the second largest supplier of electronics goods to the United States. Last year, it exported $3.2 billion, behind Japan at over $20 billion, but ahead of Canada, Mexico, Singapore and South Korea which each exported around $2.5 billion, according to figures from the American Electronics Association.

And in overall economic terms, Taiwan's trade surplus with the United States is mushrooming. Last year it was about $10 billion; this year it could be nearer $15 billion, according to the Taiwanese government. Anxious about the growing threat of protectionism, the country's External Trade Development Council recently issued a lengthy report. It proposes that Taiwan mobilize its vast foreign-exchange reserves (expected to be $35 billion this year, which is almost as much as Japan's) to fund several major capital investment projects.

GI's Klein thinks that these big-ticket items — nuclear power plants, a subway system for Taipei, improved telecommunications and better production technology at factories — offer some interesting possibilities for U.S. and European capital electronics suppliers that do not compete with Taiwan's local industrialists. He hints that the government will try hard to soothe sentiments by favoring American contractors over competitors from Japan or Korea, but adds that this benefit will be small.

Adds Tatung's Wang: "Although we'd like to import more precision machinery and components, we need products that are appropriate to our needs. I think U.S. products often need minor changes to meet the demands of the Orient, and, of course, they must be competitive with products from Japan, Korea and Europe."

Most observers in Taiwan say that the country will succeed in making the transition into the fast-growing markets of the future. Concludes GI's Klein: "Taiwan will get into high-technology. It's going to be slow and on an individual company basis. [But] it will be permanent."

ANDREW TANK

Tank is an India-based journalist who travels extensively in Asia.

Consumer electronics: More to see and hear in 1987

Consumer electronics products continue to thrive although a stronger yen is squeezing Stateside dollar margins

For consumer electronics companies, the good news is that demand for most audio and video equipment is expected to continue to grow at a healthy rate through 1987 — with sales of popular items like compact disc players and big-screen projection televisions expected to soar. The bad news, however, is that price pressures are cutting back profit margins to a dangerous level. There has been "a chaotic erosion in the industry's prices," says Bob O'Neil, executive vice president of Hitachi Sales Corp. of America. "Few companies are making an adequate return on investment."

Making matters worse is the strength of the yen, worth about one-third more against the dollar than it was last year. Most consumer electronics products sold in the United States, of course, are imported from Japan. "We're caught in a dollar/yen squeeze," says Terry O'Flynn, senior vice president of Mitsubishi Electric Sales America Inc. and head of the company's audio/video group. Despite steady sales increases, O'Flynn says, "the bottom line will not look good because of the exchange rate."

Japanese companies are trying to counteract the double whammy of price cuts and the strengthening yen by building more equipment and buying more components in the United States. In September, for example, Mitsubishi opened its second U.S. color television facility. To start, the facility located near Atlanta will have a capacity of 20,000 televisions a month, but production will be expanded to meet demand, according to O'Flynn. Mitsubishi's other facility is in Santa Anna, Calif. Hitachi Consumer Products of America Inc. opened an assembly plant in Anaheim, Calif., in 1986.

Another countermeasure is creative marketing. Hitachi executives are per-

Three turn-ons in U.S. consumer electronics

	1985	1986	1987
Value ($ millions)			
Compact disk players	$217	$350	$425
Home VCRs	$4,735	$5,500	$5,900
Projection televisions	$488	$570	$610
Units (thousands)			
Compact disk players	966	1,800	2,500
Home VCRs	11,900	13,200	14,600
Projection televisions	266	320	350

Source: Electronic Industries Association

John McIntosh

sonally pushing their products across the country. In a 15-city road show — the theme of which is "Marketing for Survival" — Hitachi officials hope to teach some 2,000 retailers strategies for profitable merchandising. With profit margins so low, manufacturers argue, prices must be allowed to stabilize and volume must be increased to bring in more earnings. "Profitable volume is imperative if [product] innovation and merchandising are to remain strong and effective," says O'Neil. Hitachi also is promoting its

Despite squeezed profit margins, the picture has some bright spots. In 1986, for example, projection TV sales increased 20% to about 320,000 units from 266,000 units. To consumers, says O'Flynn of Mitsubishi, "bigger is better, because they are bringing the movie theater home." Bigger is also better for manufacturers, who generally have higher profit margins on these items.

Compact disc (CD) player shipments, meanwhile, increased to 1.8 million units in 1986 from a mere 35,000 units when CD players first hit the market in 1983, according to the Electronic Industries Association (EIA). In 1987, CD player sales are expected to climb to 2.5 million units.

With average unit factory prices dropping from $429 in 1983 to an estimated $170 in 1987, CD players have gone from being an expensive luxury for the elite to a major mass market item. Demand has exceeded industry expectations," says Allan Schlosser, EIA spokesman. Schlosser points out, however, that this "extraordinary growth" cannot be sustained for more than another year or two.

Growth of video cassette recorders (VCRs) also is expected to slow as market penetration increases. More than 40% of U.S. households reportedly now have VCRs, according to the U.S. Department of Commerce. And by 1992, the commerce department projects, two-thirds of all households will own video cassette recorders.

For now, though, VCRs are closing in on color TVs, a mature market that is holding relatively steady, as the cash cow for the consumer electronics industry.

Demand for audio products firmed in 1986 — with consumers interested in stereo systems as well as compact disc players. In traditional systems, buyers showed a decided preference for the convenience of complete stereo systems.

BETH KARLIN

Vision system vendors eye a board market

Printed circuit board builders are demanding automated inspection systems. An AOI multitude for multilayers

Question: What happens when 20 suppliers of bare printed circuit board (PCB) inspection systems spend over $100 million on product development in pursuit of a $50 million market? a) a vendor shakeout b) a smorgasbord for customers c) mass confusion. Answer: all of the above.

"We're in a classic immature market where everybody's trying to leapfrog everybody else technologically, and R&D [research and development] spending is way out of proportion to the size of the industry," says Paul Shirra, assembly and test product manager for Hughes Aircraft Co.'s Industrial Products Division. The division offers an automated optical inspection (AOI) system that uses laser imaging to inspect the artwork and inner layers of complex boards (up to 42 layers).

Reliable estimates peg the present worldwide installed base of these automated systems at only 200 to 225, representing about $50 million in capital spending. About 75% of the installed base, or 160 installations, belongs to one company, Optrotech Ltd., an Israel-based firm that pioneered AOI for bare boards three years ago. The second-leading supplier, with an estimated 20 to 30 installations, is another Israeli company, Orbot Systems Ltd. Other players with multiple system sales are said to include DIT-MCO International of Kansas City, Mo.; Hughes; and Visionetics Corp., a Connecticut start-up founded by former executives at Perkin-Elmer Corp. These, and an estimated 15 other suppliers, are scraping for orders in a 1986 market of no more than $30 million. Some optimistic analysts see pent-up demand for another 1,000 systems pushing the market to $60 million next year and $200 million by 1990, but a more prevalent view is that a shakeout is coming first, spurred by a parallel shakeout among merchant PCB vendors [ELECTRONIC BUSINESS Sept. 1, 1986 p92].

What is not in question, however, is the absolute necessity of AOI for probing outer and inner layers of sophisticated multilayer PCBs. Peter Bolda, the president of Basic Electronics Manufacturing Corp., a small merchant supplier of boards with up to 15 layers, says the company simply could

Tim Davis

OPTROTECH VICE PRESIDENT McDONALD says demand this year alone reached 600 systems in the automated optical inspection market

Drop continental manners, learn the local customs

U.S. firms regarding Europe as a single market will starve. Those seeing each country will feast

By Jack Gee

When Apple Computer Inc. launched its first drive into the European market, the company committed a series of strategic errors. The chief one was failing to recognize individual European countries as having separate markets, treating them instead as a homogeneous entity.

Apple paid a heavy price for failing to identify the differences between Europe's national markets for microcomputers. That ignorance prompted the company to make poor choices in almost every country where it selected local distributors. The exception was France where for years Apple's machines valiantly outsold IBM personal computers.

Michael Spindler, the current general manager of Apple's International Division, recalls: "We have done particularly well in France because we started out with an excellent French team who did a faultless job. We also had a very capable, visionary and outspoken general manager. Unfortunately, we did not have that situation elsewhere in Europe." The captain at Apple's helm in France was Jean-Louis Gassée, a Frenchman whose talents have since earned him an executive vice-presidency position at the Cupertino, Calif., headquarters where he is responsible for product development.

The core of the problem

Apple's early setbacks in Europe are far from the exception. Other U.S. electronics companies have bungled the job of devising strategies for a market with a population comparable to that of the United States but where, every few hundred miles, a national frontier with a formidable array of tariff barriers stands in the businessman's path.

FINLAND
NORWAY
SWEDEN
POLAND
FRANCE
SPAIN

> "Although the Europeans talk about their Common Market, a single market just does not exist"
>
> Robert Heikes of ES^2

"Although the Europeans talk about their Common Market, a single market just does not exist," says Robert D. Heikes, who successively managed the European semiconductor operations of Motorola Inc. and National Semiconductor Corp. before becoming cochairman of European Silicon Structures. ES^2, located in the south of France, is the first company in Europe to design and prototype custom chips for the European market, which Heikes describes as "a terribly fragmented place in which to operate."

Others share Heikes' view. "The European market is really 14 different markets. There's one for each country, even for the tiny Duchy of Luxembourg," says Gordon Curran, associate director of Intelligent Electronics, a Paris-based market research firm. "But American electronics firms, particularly those in the office automation business, must not confuse smallness of scale with lack of maturity. And, although Europe as a whole is still not as big a user of microcomputers as the U.S., it is a highly sophisticated marketplace."

To U.S. newcomers that seek advice on how to make the plunge into the European market, Curran stresses that they cannot find a one-stop marketing solution. "You've got to have an Austrian managing your business in Austria and a German in Germany. Don't believe that a German can handle Austria simply because the people there speak the same language. Make sure you use local nationals in each country."

Technology counts

Curran also warns U.S. manufacturers that they cannot expect to make a dent in the European microcomputer market unless they offer unique products that challenge Apple, IBM and Italy's Ing. C. Olivetti & Co. (the No. 2 microcomputer seller in Europe). "The entry ticket is also becoming increasingly costly. Huge investment is necessary to set up market support and dealerships," Curran says. "And don't expect to sell a product in Europe if it has not succeeded in the U.S."

U.S. companies, as well as technology, face formidable competition. Klaus D. Kreuzer, senior director and manager of international marketing at Siemens' Data Systems Division, comments: "U.S. firms such as IBM are going to have an increasingly hard

Photograph/Dilip Chauhan

time in Europe as firms such as Siemens and Olivetti gather strength in the office automation business. The fight for market share is getting tougher for the Americans."

Aside from offering technological advice, market researcher Curran also counsels U.S. electronics companies against using Britain as a launching base for a European operation. "Of course there's a language advantage there for Americans," he agrees, and "flight time from the U.S. is also one hour shorter than to continental Europe. But Britain lies on the edge of the continental market, far from the main centers of penetration which lie in Germany and France."

"Don't believe you can use Britain as a soft option for stepping into mainland markets," echoes Roy Bright, a telecommunication consultant at Orpington, England. He cautions U.S. manufacturers not to pattern their sales strategy in continental Europe on their experience at home or even in Britain.

Learn the language

"It's very important to make sure that your brochures are adapted to local markets. A straight translation of the English-language original is not good enough, " Bright asserts. "And the glossy corporate documents favored by U.S. corporations cut no ice in Europe. Potential buyers of your product are not sensitive to hype. They want to know about its technical advantages."

IBM appears to have learned this lesson. Users of its personal computers in Europe often claim that the instructions from the local-language versions of its documentation are much easier to execute than those of the original English editions.

Bright spurred the marketing drive for Britain's Prestel videotex and then spent a five-year stint promoting French products worldwide for the government's Direction Générale des Télécommunications. He tells Americans not to underestimate the level of technology in France. "Whenever I go to the U.S. I remind people that France is no longer just champagne, fancy cheeses and high-class dresses," he says. "When marketing their own products, Americans must never forget that this is the country which converted its own population to videotex and introduced the microprocessor-memory credit card."

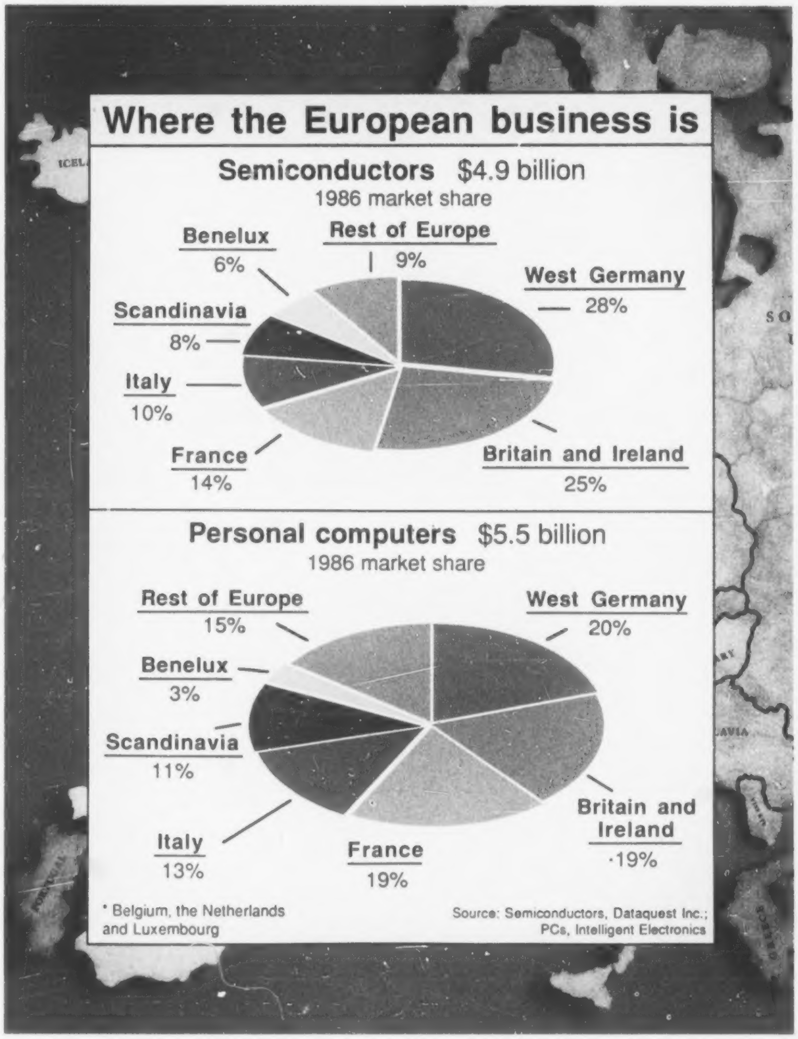
Most of the U.S. electronics companies that today perform successfully in Europe started out with local sales offices before embarking on full-scale manufacturing. "Before taking risks with a brand-new plant, a company must first test its product on the European market," suggests André Borrel, vice president for international semiconductor operations for Motorola, which followed such a course. Borrel, a Frenchman, headed Motorola's European semiconductor operations until earlier this year, when he moved to the company's worldwide semiconductor headquarters in Phoenix, Ariz.

"Semiconductors are global products," he explains. "You can sell them anywhere — in France, Britain, Germany — in the same way as in the United States — because a device's standards do not change from one country to another. The same applies to computers. A VAX from Digital Equipment Corp. is the same machine on both sides of the Atlantic."

But the same approach does not apply to all European electronics markets, however. With telecommunication equipment, defense products and consumer goods, U.S. manufacturers accustomed to selling a standard piece of merchandise back home will find themselves battling a maze of regulations and government-imposed standards differing from country to country. "This means that the newcomer from the U.S. usually has to spend a lot of money to develop his product to match each set of standards," Borrel remarks. "Very often, he'll decide it's not worthwhile."

European managers take over

A couple of decades ago, when many U.S. electronics companies were still newcomers to Europe, it was easy to find American managers and engineers in their companies' European plants and offices. Today this is the exception rather than the rule. All U.S. firms prefer to hire Europeans. "That way, they achieve better synergy between their own corporate requirements and the European environment," says Motorola's Borrel. "But it's important for companies,



Where the European business is

Semiconductors $4.9 billion
1986 market share

Personal computers $5.5 billion
1986 market share

* Belgium, the Netherlands and Luxembourg

Source: Semiconductors, Dataquest Inc.; PCs, Intelligent Electronics such as ours, to send people to the States regularly for training and for U.S. managers and engineers to do stints in Europe."

IBM is a company where it is extremely unusual to meet an American on full-time assignment in Europe. As with Motorola, and many of its direct competitors, Big Blue also gives emphasis to a constant trans-Atlantic flow of personnel. Jean-Pierre Briant, vice president for manufacturing, systems and technology at IBM-Europe, says: "Our European plants profit from these exchanges. And our American colleagues also learn a lot from working alongside Europeans in the U.S. That's how IBM pushes up yields and improves quality. Thanks to this cross-fertilization, our European plants are ahead about half the time and the Americans the other half. In this way, we avoid complacency."

IBM's BRIANT: "Our American colleagues learn a lot from working alongside Europeans"

IBM is not alone in recognizing the quality of Europe's managers and engineers. These professionals are earning increasing respect in the United States. "No U.S company can afford to underrate Europeans," says Marco Landi, European semiconductor marketing director for Texas Instruments Inc. "And very few do."

The TI executive considers this new respect paid to European managers as the outcome of a radical change in Europe's attitude toward the electronics industry. "The European semiconductor companies are moving out of their local arena and targeting world markets," Landi explains. "And to do this they are doing what the Americans did years ago. They, too, are crossing the Atlantic."

N.V. Philips of the Netherlands took the lead in 1975 when it acquired Signetics Corp. in order to establish a U.S. presence. Germany's Siemens followed suit when it bought a 15% stake in Advanced Micro Devices Inc. France's Thomson SA continued the trend, buying most of Mostek Corp.'s assets last year from United Technologies Corp. And SGS of Italy has built a state-of-the-art wafer fab in Phoenix, but it is postponing completion until signs of a market revival for the semiconductor industry emerge.

"All these European firms have something to offer the U.S in exchange for American technology," TI's Landi remarks. "It's a two-way street. In our company we have confirmed our confidence in European technology by our recent alliance with Philips to develop advanced CMOS [complementary metal-oxide semiconductor] logic devices together."

"The U.S. firms have always done a good job in Europe," says Jacques Noëls, chairman and managing director of Thomson Composants, the electronic components division of the state-owned French group, and former president of Texas Instruments-

Choosing a business location in Europe

It is essential for U.S. electronics manufacturers to look at each of Europe's fragmented marketplaces from close at hand. "You've got to get the dirt under your fingernails and create the personal interface in each country," says Gordon Curran, associate director of Intelligent Electronics, a Paris-based market research firm. "You can't depend on reports and statistics and what other people tell you."

U.S. companies intending to build plants or establish marketing networks in Europe should not focus on countries that offer the most generous fiscal advantages, Curran advises. They should choose a site that has the best possible market penetration for their products. The market researcher adds, "In order to sustain your high investment and operational costs, it's wiser to set up your business in a country with a big national market."

The Netherlands probably has the most attractive banking environment. But the local market is small. The French invented the word "bureaucracy" — and are the best practitioners of it in Europe. But, in spite of all that red tape, U.S. firms such as Fairchild Semiconductor Corp., Intel Corp. and Texas Instruments have all discovered compelling business arguments for establishing their European headquarters in France.

Curran himself was drawn to France five years ago when he and his wife, Brigitte Morel, set up their market research firm. "Paris was clearly the best place from which to monitor Europe," says Curran, a Scottish engineer.

"But we can't just sit behind our desk on the River Seine's Left Bank and discover what's going on in the other thirteen national European electronics markets outside France," declares Morel, a former marketing manager for a big U.S. cigarette company. "It means visiting each of them at least twice a year." □

France. "Now the Europeans have learned the lessons taught by their American mentors and are targeting world markets. And we're achieving our objectives with smaller resources. Too often, the U.S. firms indulge in overkill to arrive at the same results."

Japanese up the ante

Increasingly, U.S. companies are discovering that their comfortable European market shares are being nibbled away at by Japanese rivals. "Japan is putting a lot of design resources into Europe," observes Peter Savage, associate director for the European Semiconductor Division of Dataquest Inc., the San Jose, Calif., market research firm. "They will double their sales here over the next year or so," says Savage.

NEC Corp. has installed a wafer plant in Livingston, Scotland, and Hitachi Ltd. has also established one in Landshut, West Germany. Savage warns: "The Japanese are now putting down a serious challenge to European and U.S. manufacturers with design resources that target Europe's growing market for application-specific integrated circuits."

The Japanese are also mounting an assault on another U.S. bulwark in Europe, the semiconductor equipment-manufacturing industry. Philippe Geyres, director of Thomson SA's bipolar division, who recently set up a new plant for his company at Maxeville in eastern France, ordered 80% of its equipment from Japan. "We bought only the computers and tester from the U.S.," he reports.

Geyres congratulates Oki and other Japanese firms for the skill and energy they used to win and execute the Thomson contracts. He says: "The Japanese still have a problem in providing after-sales service in Europe. American firms, such as Teradyne and Perkin-Elmer, are so long-established here. But many U.S. manufacturers are resting on their laurels in Europe."

Geyres' boss, Noëls, is also keenly aware of the advances Japanese equipment suppliers are making in Europe at the expense of their U.S. competitors. "The Americans remain very strong on innovation," says the chief of Thomson's semiconductor operations. "But, by optimizing the use of semiconductor equipment, and in test machines, the Japanese are grabbing markets in Europe."

MOTOROLA's BORREL: "Before taking risks with a brand-new plant, a company must first test its product on the European market"

Managers of electronic companies differ in their views on the ease of operating in Europe. Some find it more stimulating than working in the United States. Others say that Europe still lags in engineering and marketing skills.

The semiconductor environment in the United States is far more conducive to business than in Europe, argues Daniel Queyssac, president of SGS USA, a subsidiary of Italy's SGS. "The rules are clearer here," says this Frenchman, who hopes to become an American citizen soon. "In the U.S., performance is the key criterion. Europe is entwined in too much politics, national product specifications and rules — either spelled out or unwritten — that restrict opportunities for suppliers."

Changes ahead in the European semiconductor market

	1986	1991
Integrated circuits	75%	86%
Discrete devices	20%	10%
Opto-electronic devices	5%	4%
Total market ($ billions)	$4.9	$12

Source: Dataquest Inc.

Queyssac adds: "In Europe business relationships are too cozy, and people are too tolerant of mistakes. In the U.S., if you drop the ball, you don't get any support. And that's the way it ought to be."

Heikes, the Motorola and National Semiconductor veteran, disagrees. "I don't detect all that difference between doing business in the U.S. and Europe," he says. "In fact, in many ways it's easier for a semiconductor manager to run his business here than in the U.S."

Although a top manager at a U.S. subsidiary in Europe might find himself dealing with a lot of customers smaller in size than he would find in the United States, he exercises more responsibility and authority than he would back home. "The distance between himself and his U.S. headquarters allows him more scope for initiative than a person in an equivalent stateside job," Heikes maintains. "He also has an advantage over European managers at his own level because their corporate bosses are probably sitting in the next room, reviewing the accounts day by day. In Europe, he's not working in a strange new world. His competitors are the same big U.S. semiconductor companies against whom he has always been contending."

U.S. managers in Europe are often

more motivated than their European counterparts, Noëls agrees. "But now we at Thomson are learning how to run a hands-off, long-distance operation following our acquisition of Mostek," he says.

Heikes discounts the strength of the challenge from the European semiconductor companies and is dubious about whether Thomson's purchase of Mostek assets will finally pay off. He says: "During my many years in Europe I've seldom lost an order to any European semiconductor manufacturer. I would not even agree that national loyalties operate in their favor. It's always price that determines the outcome."

The toughest nut to crack

In telecommunications, however, U.S. firms find themselves handicapped against their European rivals. In seeking to sell their switching systems, manufacturers must obtain approval from regulatory bodies in each country. "Getting approval for his product in one country may delude an American vendor into believing he can go ahead and sell it all over Europe," says consultant Bright. "But he has to go through the process in each country. It's not a once and for all arrangement like in the U.S."

THOMSON's NOËLS: "Europeans have learned the lessons taught by their American mentors and are targeting world markets"

Even in Britain, the only country in Europe where telecommunication carriers have been deregulated, this protracted process still presents a hurdle. British Telecom recently recruited more staff to speed up the approval procedure, covering modems, private branch exchanges (PBX) and big switches, which currently takes between three and six months.

France is particularly inhospitable to foreign equipment. To protect its own modem manufacturers the country has approved only a handful of U.S. modems for use on its growing data network, which is totally controlled by the government-managed Direction Générale des Télécommunications.

Support, either blatant or discreet, for national companies by European governments and their agencies acts

Washington isn't helping

It is not just European trade barriers and strategic errors by U.S. electronics companies that are handicapping U.S. business in Europe. President Reagan's controls on high-technology exports also have proved a hindrance.

A survey conducted recently by U.S. government officials in West Germany reveals that European customers of electronic components and equipment are complaining that curbs imposed by the White House delay shipments. According to the survey this occurs so much that the customers are turning to other suppliers, either from Europe or, more increasingly, from Japan.

The survey, organized by the commercial section of the U.S. Embassy in Frankfurt, West Germany, indicates that the Reagan controls are spurring several companies — either German-owned or U.S. subsidiaries — to redesign their products. The objective is to incorporate fewer U.S. parts and, instead, use more readily available European or Japanese components.

One German distributor of electronic components estimates that it is switching 25% of its component orders away from U.S. suppliers and toward Japanese firms in order to meet the requirements of local manufacturers.

U.S. companies in Germany also are complaining that compliance with the Reagan restrictions is boosting their administrative overhead. For big companies this cost has risen as much as 25%.

The firms questioned in the survey indicate that they are determined to change from U.S. suppliers unless the White House behaves more flexibly about exporting U.S. technology.

For some years now, U.S. allies have been complaining that Washington has been restricting sales of high-tech equipment to the western area in order to prevent such equipment from being reshipped to the Soviet Union and other Communist states in Western Europe.

At an East-West trade fair in Leipzig, East Germany, Getac Instrumenbau, a small West German company, put up a sign in its booth that proclaimed: "American embargo regulations do not permit our systems to be exhibited."

Hans J. Fiedler, Getac's sales manager, claimed that his company's shipments of U.S.-made instruments to Eastern Europe had been crippled by tightening American restrictions on high-tech exports. "But the cowboys are prospering," Fiedler grumbled, referring to underground salesmen. "They're prepared to deliver whatever the Communists want — at a price." ☐

as a powerful deterrent to foreign suppliers. Substantial chunks of the public switching business — usually up to 50% of the market — are guaranteed to Siemens by West Germany's Bundespost, to Philips by the Netherlands telephone authority, and to Italtel by Italy's SIP. "These market shares are not necessarily written down. That does not matter because they are rigorously applied," says Bright.

Weighing the advantages and disadvantages of doing business in Europe is not an easy task for a company that is hesitating to make the leap across the Atlantic. It is certainly easier for the long-established companies, such as IBM whose European presence nearly dates back as far as its founding, than it is for those that are disembarking today. But European governments, concerned about high levels of unemployment, welcome investment from these newcomers. Some are even trying to unravel the red tape which so often discourages U.S. entrepreneurs.

Praise for U.S. quality

What matters more, perhaps, is that the United States' European customers in electronics continue to applaud the quality of service that they are getting. Pierre Alex, president of France's component distributors body, Syndicat Professionel de Distributeurs Electroniques Industriels, says: "The Americans never let us down. However, the European manufacturers are now offering new, interesting chips. This reflects the new vigor which has been infused into our own semiconductor industry."

Some European culture has been infused into U.S. companies as well. "The American suppliers have learned a lot in Europe during the past 20 years," says Gerard Pasturel, president of the French semiconductor components manufacturers' professional federation, Syndicat des Industries des Composants Electroniques et Semiconducteurs. "In the old days they often stamped around in big Texan boots. Now their mentality has changed. They're more chameleon-like and use many more Europeans to run their operations here."

Whether they uncork a bottle of French champagne, British beer or German schnapps, the U.S. electronics industry's managers in Europe would certainly raise their glasses to that tribute. ☐

DEC focuses products on its fastest growing market

Digital Equipment Corp.'s European sales rose 16% to $2.2 billion in 1986. More of the same is expected in 1987

When Digital Equipment Corp. recently spent $5 million to invite 15,000 of its European clients to DECville, a lavish two-week, company-sponsored trade show on the French Riviera, it had something more original to propose than computers which had already been launched in the United States. Targeting its fastest growing market, DEC set out to demonstrate that it is now crafting products specially for its customer base in Europe.

DEC is putting up a particularly encouraging performance on that continent where sales in the fiscal year that ended last June rose 16% to more than $2.2 billion from the same period a year earlier. That compares with the company's worldwide growth of 14% on sales of $7.6 billion. DEC, which is headquartered at Maynard, Mass., keeps a workforce of 21,000 busy in Europe out of its 95,000 employees around the globe.

"We can expect our sales and earnings in Europe to grow even faster in the current fiscal year," predicts Pier-Carlo Falotti, president of Digital's European operations. Analysts say this factor will be a crucial one in helping the manufacturer to compensate for the continuing lack of buoyancy in the U.S. market. DEC's sanguine European outlook sharply contrasts IBM's view.

Kenneth Olsen, DEC's president and founder, who flew over to open the Riviera extravaganza in Cannes, shares Falotti's confidence. He says DEC will continue to "do well" in the United States. But he stresses that the U.S. computer industry will have to continue wrestling with a slump for some months ahead.

Designs on special markets

Among the VAXmates and other recent stateside DEC designs on show at DECville was a videotex terminal developed in France for which the manufacturer forecasts a glowing European future — but perhaps no market to speak of in the United States, at least for a moderate period of time.

The terminal has been conceived

DEC's EUROPEAN CHIEF FALOTTI: "We can expect our sales and earnings in Europe to grow even faster in the current fiscal year"

Influential accents: Foreign firms gain in U.S. markets

Foreign companies are continuing to expand their presence in the U.S. market. Ten foreign firms have a billion dollar impact

By Fred McGrail and Linda Stallmann

The competition in U.S. markets from foreign electronics companies is evident at a glance at those companies' electronics sales figures. Based on U.S. sales, the top 10 foreign companies would all rank among the top 50 of the ELECTRONIC BUSINESS 200, the magazine's annual ranking of the leading U.S. electronics firms. The leading foreign company, Japan's Matsushita Electric Industrial Company Ltd., would rank ninth, between Hewlett-Packard Co. and Motorola Corp., with U.S. electronics sales of $6.52 billion.

All 10 of those companies, six of which are Japanese, each sold more than $1 billion worth of electronics in the United States. Another three companies were close to the billion-dollar figure, topping $900 million in U.S. sales.

But if foreign companies are selling more in the United States, they are also building more plants here and employing U.S. workers. Kathleen Molony, a senior analyst with Data Resources Inc. in Lexington, Mass., sees several factors that lead her to believe that trend will continue. Part of the reason that Japanese firms, for instance, have in the past located some plants in the United States was to ease trade tensions, Molony says. But the recent rise in the yen has also made moving operations to the United States more economically feasible. NEC Corp., for instance, has five major plants in the United States employing 5,000 workers, manufacturing everything from telecommunications gear to semiconductors, and plans to open more.

The movement of manufacturing operations outside Japan is similar to what U.S. companies did during the 1970s, says Daniel Hefler, director of global sourcing with the Arthur D. Little Co. The large decline in the value of the yen caught both the Japanese and the Americans by surprise, he says, and has hurt Japanese electronics firms.

"The Japanese will do whatever it takes to maintain [U.S.] market share. Market share is of paramount importance." Meanwhile, though, Japanese companies are absorbing some losses in electronics, he says. "They're taking it on the chin, but they're willing to take the losses because they don't think it [the devalued yen] will be forever."

Ten companies, six of which are Japanese, each sold more than $1 billion worth of electronics in the United States

"The trend toward establishing foreign manufacturing facilities has some Japanese worried," says Molony. "There is a greater push to sell and produce more in the U.S.," she says, and that has raised concerns about the impact on the Japanese employment picture. "Some people in Japan are becoming concerned," Molony says, "particularly about the impact on less skilled Japanese workers." While there is a benefit to the United States in terms of jobs, the revenue from such enterprises will still go to the Japanese companies, Hefler points out.

In addition to the Japanese moving operations offshore, Molony also anticipates more joint ventures between foreign and U.S. companies. "I think we'll see more tie-ups between Japanese and American firms," she says. One such agreement, between Honeywell Inc. and NEC, has quickly drawn cries of protest. The Air Force awarded a $33 million contract to Honeywell for a computer system which will be used to schedule flights and provide weather information.

The computer was designed by NEC, and utilizes NEC central processors and chips, while Honeywell provides software and peripherals. Control Data Corp., which lost in the bidding for the system, alleged that NEC used the Honeywell connection to gain entry to the U.S. government armed services market, which has been the sole province of U.S. companies. Control Data Corp. also charged that the price suggests NEC is dumping products into U.S. markets. NEC denies both allegations.

Whatever the final determination, the tie between NEC and Honeywell is a clear example of one Japanese company's aggressive attempt to move into a new U.S. market. Having gained dominance in the area of consumer electronics, but now facing a real threat from Korean companies, foreign companies, particularly the Japanese, are looking to new horizons. "The Japanese have targeted electronics," Molony says, "and they clearly want dominance."

But while Japanese companies dominate the top 10, European firms are also well represented on the ELECTRONIC BUSINESS list, with both West Germany's Siemens and the Netherlands' N. V. Philips' GL in the top echelon, joining Canada's Northern Telecom Ltd. The United States represents the most lucrative market in the world, so it is hardly surprising that foreign companies are tapping it. "It [the U.S. market] is no longer ours," says A.D. Little's Hefler. ☐

Top foreign companies in the United States

Company	U.S. electronics sales ($ millions)	Total consolidated sales ($ millions)	Profit before taxes ($ millions)	Fiscal year ended	Country of origin
Matsushita	$6,520	$24,890	$3,396	11/85	Japan
Philips	3,430	18,140	525	12/85	Netherlands
Northern Telecom	2,870	4,252	434	12/85	Canada
Sony	2,250	6,702	669	10/85	Japan
Sharp	1,460	N/A	N/A	3/86	Japan
NEC	1,450	13,116	662	3/86	Japan
Siemens	1,340	20,425	1,423	9/85	West Germany
Toshiba	1,310	18,739	725	3/86	Japan
Sanyo	1,200	5,163	N/A	11/85	Japan
Canon	1,090	4,779	444	12/85	Japan
Mitsubishi	1,000	8,139	397	3/85	Japan
GEC	980	7,735	1,032	3/86	Britain
JVC	950	2,978	209	3/85	Japan
Schlumberger	900	6,557	617	12/85	Netherlands
Hitachi	720	29,473	2,183	3/86	Japan
Fujitsu	650	9,399	283	3/86	Japan
Olivetti	620	3,684	323	12/85	Italy
Samsung Electronics	550	N/A	N/A	12/85	Korea
C. Itoh	500	88,528	141	3/86	Japan
Kyocera	485	1,568	241	3/86	Japan
Racal	470	1,865	133	3/86	Britain
TDK	430	2,124	351	11/85	Japan
Thorn EMI	430	4,884	154	3/86	Britain
Oki Electric	400	2,181	12	3/86	Japan
Lex Services	390	1,507	34	12/85	Britain
Pioneer Electronic	390	1,572	21	9/85	Japan
Commodore	360	889	-128	6/86	Bahamas
CGE	320	10,390	221	12/85	France
Ericsson, LM	310	4,281	165	12/85	Sweden
Thomson	300	7,831	97	12/85	France
Plessey	260	2,152	251	3/86	Britain
Alps	240	2,003	111	3/86	Japan
Mitel	130	302	-65	3/86	Canada
Nixdorf	130	1,604	123	12/85	West Germany
Mannesmann	120	7,425	334	12/85	West Germany
Smith Industries	120	525	65	7/85	Britain
Canadian Marconi	110	166	27	3/86	Canada
AEG-Telefunken	100	4,900	N/A	12/85	West Germany
Advantest	80	371	84	3/86	Japan
SGS	70	306	-20	12/85	Italy

Source: ELECTRONIC BUSINESS

DSPs: Clear signals for a rising market

Digital signal processing, once restrained by technology and high prices, is now on the monolithic move

By Carol Suby

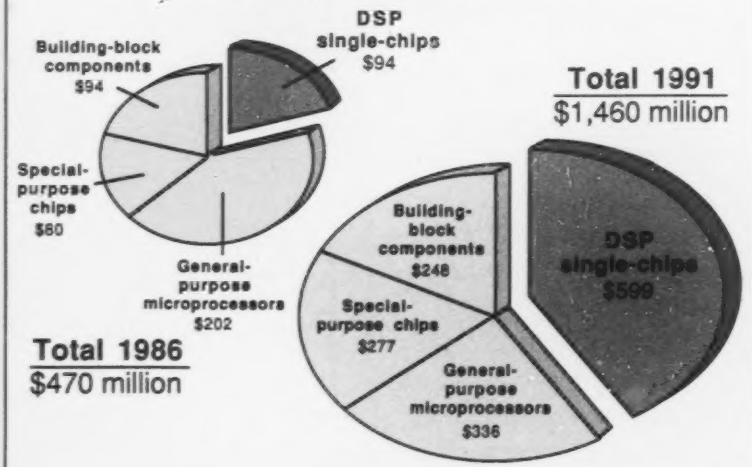
Although digital signal processing — digital processing of analog signals — has been around for more than a decade, its progress as a viable component market has been snail-paced. Before 1980, the digital signal processor (DSP) market was restrained by a lack of technology and high price tags. However, recent progress in the development of very large scale integration (VLSI) semiconductor circuits, advances in complementary metal oxide semiconductor (CMOS) technology and the creation of more elegant architectures have all contributed to drive DSP use beyond the high-end military arena to include the commercial market, where potential uses are myriad and hold the promise of volume sales.

THE MARKET

Today, semiconductor manufacturers are looking to DSPs as a golden opportunity to boost sluggish bottom lines. The numbers are impressive, holding at least as much promise as that of the microprocessor market when they were first introduced. The worldwide DSP and DSP-related integrated circuit market — including both conversion and signal processing components — is estimated to be worth $470 million for 1986, according to a report published by Electronic Trend Publications (ETP) in Saratoga, Calif. This number is forecast to reach $1.46 billion by 1991.

DSP single-chips take the market by storm

Worldwide digital signal processor shipments ($ millions)



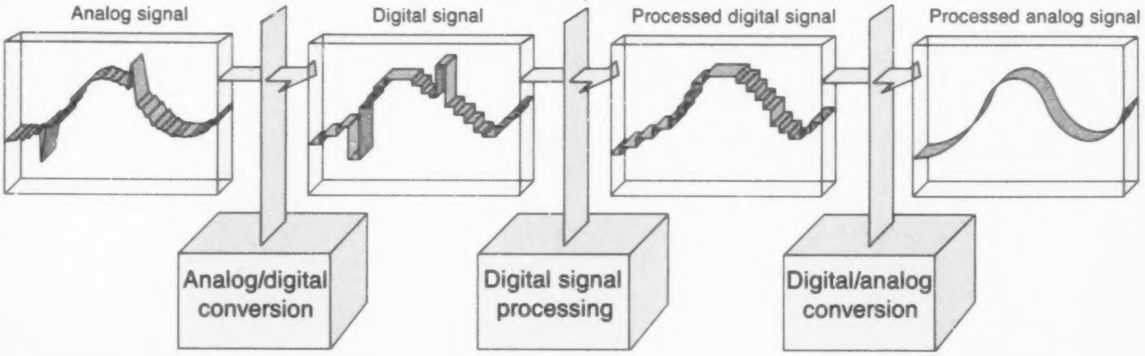
Source: Electronic Trend Publications

Calling 1986 "the year of the DSP," William Strauss, president of research firm Forward Concepts in Tempe, Ariz., points out that there have been more DSP product announcements in 1986 than in the entire history of DSPs. Strauss expects the DSP and DSP-related integrated circuit market to be worth more than $6 billion by the end of 1993.

The commercial DSP history began when Japan's NEC Corp., and Dallas-based Texas Instruments Inc. were able to produce successful single-chip, general-purpose DSPs in the early 1980s. "Getting a DSP solution in a single chip [is] what finally caused the market to explode," says John Rizzo, marketing vice president at Weitek Corp. in Sunnyvale, Calif. These programmable single-chip DSPs were easier to incorporate into systems and were also far less expensive than the building-block approach to signal processing. The use of multiple components for signal processing had been around for some time but was expensive and applications were limited almost entirely to the military.

At the low end of the DSP market, components handle applications within the audio range, at frequencies of 25 kilohertz (KHz) and below. Midrange is considered to be between 25 KHz and 500 KHz, where video and telecommunication multiplexing functions are performed. The high end, which includes radar, radio and television type applications, is found at frequencies as high as 100 megahertz (MHz). Anything beyond that is either for military or experimental applications, says Strauss of Forward Concepts.

What single-chip end users gain in


Analog signal
Digital signal
Processed digital signal
Processed analog signal
Analog/digital conversion
Digital signal processing
Digital/analog conversion

Working in real time

In digital signal processing, speed is the Holy Grail. In order to process real world information in real time (precisely as events occur), computers have to work at extremely fast speeds. The world functions in analog form, while our computers work digitally. A digital signal processor (DSP) takes analog signals — such as a voice or a moving target — converts them into a digital stream of bits and bytes, manipulates those signals and then reconverts the data back to analog form. Because of hardware limitations, components often could not manipulate data fast enough to keep up with the pace of signalling.

And so, although digital signal processing has been around for decades, its use in practical commercial applications has been held back. Historically, DSP components were either too slow or, if fast enough, too expensive to be applicable for most commercial uses. As a result, they were limited to military use — such as radar and sonar signal processing — where processing information in real time is of ultimate importance and price is inconsequential.

"Electronic warfare has essentially been the chief driver of DSP for years," says Willaim Groves, vice president technology at In-Stat Inc. in Scottsdale, Ariz. Indeed, fallout from the Department of Defense's (DoD) 10-year, billion dollar Very High Speed Integrated Circuit (VHSIC) program — which is spawning increasingly complex and compact chips — is already filtering down to the commercial marketplace and allowing semiconductor manufacturers more tools and technology to build more practical DSPs.

Over the last several years, Honeywell Inc. has received $80 million in contracts from the DoD under the VHSIC program and has invested nearly the same amount of its own funds to develop 1.25 and sub-micron-based chips, which, according to Pat Narendra, director of DSP products at Honeywell's Signal Processing Technologies Division, in Colorado Springs, Colo., has given them "a leg up" in the commercial marketplace. Here Honeywell is focusing on high-end, application specific DSPs produced in CMOS using 1.25-micron technology. According to Narendra, these two features "give you the performance you look for to make DSPs in affordable prices. It allows you to put four to eight multipliers operating at 25 nanoseconds each on one chip, doing the equivalent of 16 to 20 LSI chips at two to three times the speed."

> In order to process real world information in real time, computers have to work at extremely fast speeds

In fact, the progression in integrated circuit processing technologies — from bipolar, to negative-channel metal-oxide semiconductor (NMOS), to complementary metal-oxide semiconductor (CMOS) — has made it possible for manufacturers to produce DSPs that consume less power. And, although CMOS was originally slower than bipolar, it is now approaching the lower limits of top bipolar performance and more improvements are on the horizon. "The upper levels of CMOS performance have not yet been reached," says Maryann Bader, president of research firm Bader Associates, Mountain View, Calif.

In addition to changes in hardware, a shift toward more elegant architectures has also increased DSP speeds. In the pre-1980s, the von Neumann architecture, which was used in most general microprocessors, had shortcomings that slowed data flow. The Harvard architecture — which allows for the independent operations of data and address paths, thus increasing processing speed — is growing in popularity and is used in almost all general-purpose, single-chip DSPs today.

The evolutionary process of new architectures is continuing, Bader points out, and other major architectures include: parallel processors, which spread the computational burden over several devices; systolic processors, which is an extension of the parallel processor scheme, but is more powerful; and data flow architecture, which contains several processors, each able to perform different instructions. Although the data flow architecture offers enormous computational capability, it has not yet evolved to the point where it can be economically utilized. However, Bader suggests, "When it can be integrated on a single chip . . . it could well become the preferred architecture of the future." □

cost savings, however, they sacrifice in performance. As a result, initial industry assumptions that single-chip DSPs would eventually replace the building-block components have faltered. Although there may be some grey areas where both product types might compete, the smaller, more economical single-chips are mainly being used in new applications while building-block components will continue to find safe havens in niche applications.

Although applications for building blocks will also grow, they will not be in mass markets, says Maryann Bader, president of Bader Associates and author of the ETP report. On the other hand, Bader adds, the possibilities for single-chip components are at the tip of the iceberg. "We've not even begun to scratch the surface of where they're going to put those babies," she says. General-purpose single-chips are expected to grow from 20% of today's DSP market to 41%, or about $600 million, by 1991. Building-blocks will decrease a bit from 20% to 17% during that same time frame.

Another DSP product type includes general-purpose microprocessors that are used in DSP applications. These components currently account for the largest segment of the market with a 43% share. The most popular general-purpose microprocessor used for digital signal processing, according to Strauss, has been the Motorola 68000 family, followed by Intel's family of microprocessors. Although microprocessors are easily programmable, they often lack the speed of chips designed specifically for signal processing. As more alternatives become available to end users, Bader predicts that these components will decrease in use and in market share, shrinking to 23% by the end of 1991.

WEITEK's JOHN RIZZO: "Getting a DSP solution in a single chip [is] what finally caused the market to explode"

Tim Davis

The fourth product group includes special-purpose DSPs — components that are either dedicated chips (designed to operate in a specific device such as a modem) or special function chips (designed to perform a specific operation such as filtering). Although Bader does not expect special purpose DSPs to gain much in market share between now and 1991, she does expect their value to increase from $80 million to $277 million.

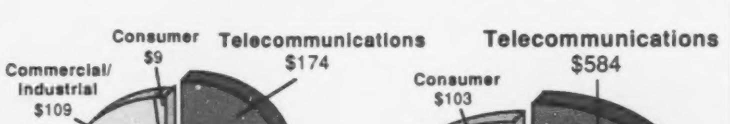
In the commercial applications arena, telecommunications is, and will remain, the stellar market. Today, Bader estimates that this segment represents $174 million, or 37% of the market. This share will increase to 40% by 1991 and grow in value to $584 million. According to Strauss of Forward Concepts, who authored a DSP report published by Gnostic Concepts Inc., by the year 1993 DSPs for telecommunications will be valued at $1.67 billion.

Sitting in the telecom DSP driver's seat, Strauss suggests, will be the implementation of a worldwide integrated services digital network (ISDN), which will require a tremendous amount of digital signal processing. For example, Codecs — a DSP chip that converts analog signals into digital bit streams and vice versa — will be incorporated into every telephone hooked into the ISDN network. Sales for this single type of DSP could be "astronomical," accounting for billions of dollars in sales over a 20-year period, ventures Strauss.

Indeed, the potential volume in telecommunications DSPs is "so huge," notes Stephen Campbell, product marketing manager for microcontroller products at Advanced Micro Devices Inc.'s (AMD) San Antonio, Texas facility, that the company has a marketing group and a design staff

Telecommunications – The stellar application for DSPs

Worldwide shipments of DSPs by major market segment ($ millions)



Source: Electronic Trend Publications

dedicated to the development and selling of chips tailored specifically to telecommunications applications.

The military applications segment, which currently represents the largest DSP market at $178 million or 38% of the 1986 market, will lose some market share as commercial applications proliferate. However, while decreasing to a 29% share of the market, its value is expected to grow to $423 million by 1991, Bader expects. Building-blocks are the most frequently used type of DSP in the military, but general-purpose single-chip DSPs are wending their way into military use as well.

Although both military and telecommunications applications will dominate DSP use long into the future, there are several other "hot" possibilites for the coming years. The use of DSPs for speech synthesis has been around for a long time, yet Strauss of Forward Concepts believes that "even greater growth [for DSP applications] will be in speech recognition." This application, he adds, is of great interest to Japanese companies, which are heavily investing in this area today.

Graphics applications — where signal processing chips are used in graphics displays and engineering workstations — will be "a biggie," says Strauss, who expects graphics to push DSP sales for computer applications from $42 million in 1986 to an estimated $1 billion by 1993. Other applications that present growth potential include: high-speed computing — where DSPs make it possible to process data at speeds of five million instructions per second (MIPS) or 20 million floating point operations per second (MFLOPS); industrial controls — where DSPs can improve both robot controls and computer-aided manufacturing; and image processing — where medical applications such as CAT scanning and ultrasound are made possible and improved.

THE COMPETITION

If DSPs become as pervasive as promised, getting involved in early design-ins can be important to future success. In the general-purpose, single-chip DSP market, two manufacturers have racked up a 93% share of this $94 million market, according to the ETP report. (Texas Instruments has 68%, and NEC has 25%.) Competition, however, is heating up. Approximately 18 new entrants — including Analog Devices Inc., Matsushita Electronics and National Semiconductor Corp. — announced products this year. Although the TI/NEC domination is expected to continue through 1991, both are expected to lose some shares to the new and existing entrants.

"The lower frequency areas are saturated," says Pat Narendra, director of DSP products at Honeywell's Signal Processing Technology Division in Colorado Springs, Colo. "You really have to look at the high-frequency DSP [one megahertz and higher] in order to penetrate the market." Nonetheless, the low end promises volumes in orders of magnitude greater than those expected for more specific, high-end components. Then again, low end does not command the higher average selling prices of the high-end products.

Getting involved in early design-ins can be important to future success

"At the high end [of the market], where performance is the overriding determining factor, [you] don't sell $25 to $30 chips," says Weitek's Rizzo. Its 3332 floating point DSP component sells for $450, or about ten times the cost of a Texas Instruments' TMS 320 DSP, and offers 20 to 30 times the performance level, Rizzo says.

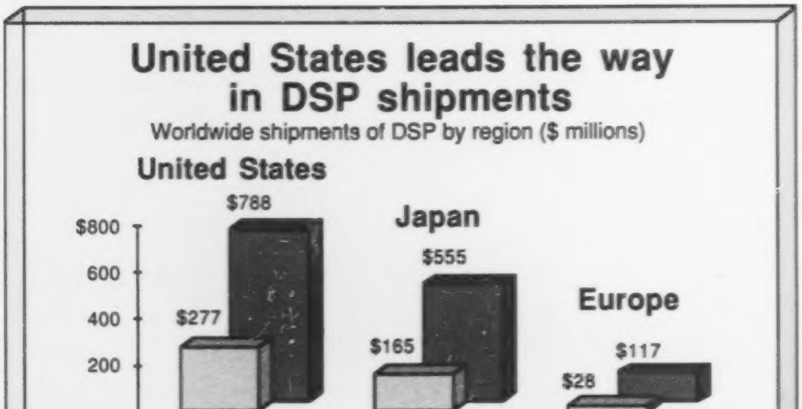
Weitek was incorporated in 1981, placing it in the start-up category. Being new on the block means finding niches where the chances of being trampled by the leading semiconductor behemoths are nonexistent. In fact, according to Rizzo, "my job is to continue to make our niches small." By being more specialized, he adds, the company is "better protected. There's not 500 people in our areas."

Leaders in the building-block DSP market include: Analog Devices with 20% market share; Integrated Device Technologies in Santa Clara, Calif. with 20%; Weitek with 20%; TRW with 17%; and AMD with 13%, according to the ETP report. Some traditional building-block manufacturers — including Analog Devices — are also extending their product lines to include single-chip DSPs.

It is not surprising to find a number of companies with strong military ties entering the DSP market. Equally unsurprising is the fact that most of them are addressing high-end areas with building-block and application-specific solutions.

Even within the military, DSP applications are varied. Lexington, Massachusetts-based Raytheon Co. is manufacturing building-block DSPs primarily for integration into a number defense systems also built by Raytheon. "Commercial users don't require the bandwidth or sophisticated algorithms used in military applications," notes Rudolf Thun, Raytheon's director of device technology. The degree of precision required in a radar system that must recognize approaching enemy jets is quite different from what is required in commercial oil exploration where simple fast Fourier transform algorithms are adequate, he suggests.

Thun estimates Raytheon's total annual output of signal processors — which in some instances are large enough to fill "quite a number of


United States leads the way in DSP shipments

Worldwide shipments of DSP by region ($ millions)

Source: Electronic Trend Publications

TI's JOHN SCARISBRICK: Utilizing third party vendors is "the cornerstone of our support"

Ben Smusz

cabinets" — runs into the thousands. Raytheon is also investing approximately $50 million in the building of a gallium arsenide (GaAs) research and manufacturing facility in Andover, Mass., which is expected to produce some DSP products.

THE OBSTACLES

Succeeding in the DSP market takes more than deep pockets and technological expertise. Before the 1980 boom time, more than one prominent semiconductor manufacturer announced products that either quickly faded into the sunset or never hit the commercial streets.

Gould AMI Semiconductors, based in Santa Clara, Calif., announced in 1978 a DSP in VMOS, which "was not a successful product," says Strauss of Forward Concepts. "The yields were abysmal," he adds, and the company was never able to get out anything beyond samples. The company later came out with an improved process, but in the interim had started to second source NEC's chip. After realizing the NEC chip was outselling theirs by a wide margin, Strauss comments, Gould AMI dropped their own product and continues to second source the NEC DSP.

Although Santa Clara-based Intel Corp.'s 2920 DSP was considered "avant-garde" at the time of its 1979 announcement — it was the first microprocessor designed specifically for digital signal processing — because of its slowness (a 400 nanosecond cycle time compared to NEC's 100 nanosecond cycle time) the product "never made a nickle for them," says Strauss.

While AT&T produced a successful product before 1980, it was not until July of this year that the company manufactured a DSP available for commercial use. In the predivestiture days of 1979, AT&T announced DSP-1. However, both this product and its second generation DSP-2, introduced in 1983, were limited to internal use in AT&T systems products such as central office switches, private branch exchanges and cellular radios. This summer AT&T announced for commercial use the DSP-32, a 32-bit floating-point general-purpose single chip.

Despite the fact that NEC was the first company to begin shipping a successful general-purpose single-chip DSP in volume, its estimated 25% of this year's forecasted $94 million market pales beside that of Texas Instruments' TMS 320 line, which was introduced in 1982 and currently holds an estimated 68% of this market, according to Bader Associates. The difference has been marketing strategy, not product capability.

Indeed, when shopping around for a DSP to use in its newly introduced 9600 bits per second modem, U.S. Robotics Inc. went with a member of the Texas Instrument's TMS 320 family. Although the company considered other vendors' products, "TI had a good support system to go with developing a use for the chip," says Dale M. Walsh, vice president, engineering, at U.S. Robotics' research and development facility in Lombard, Ill.

In addition to design tools, test equipment for DSPs is also lacking

Originally, NEC limited its DSP applications to telecommunications, an area where the company knew the product would succeed, notes William Meshach, manager for application engineering for DSPs at NEC's Natick, Mass., facility. There was a great need for DSP capabilities in telecommunications, Meshach adds, and people would pay what they had to, to get the needed performance.

In the meantime, Texas Instruments was storming the market fields, conducting seminars all over the country, familiarizing design engineers with its products' capabilities and providing a broad range of software support, all in an effort to make ease of use a reality. The key in being able to offer so much support was in utilizing third party vendors, which John Scarisbrick, TI's DSP product manager, calls "the cornerstone of our support."

NEC is now working to narrow the gap. According to Meshach, his department includes six DSP application/development engineers dedicated entirely to developing DSP product support. In addition, NEC has added approximately 30 field applications engineers to service regions across the United States, all in an effort to expand NEC's customer base beyond telecommunications.

To date, however, industry watchers agree that no other vendor is on par with the depth of support offered by TI, and this lack of support remains a hindrance in the single-chip general-purpose segment of the DSP marketplace. Few companies can offer all the necessary support.

"From an economic point of view, there's no comparison between [using third party vendors] and doing it all oneself," suggests Honeywell's Karl Stjernquist, director of the Digital Product Center in Colorado Springs, Colo. As a result, Honeywell will develop some minor software programs, but will buy third party software whenever it's financially prudent.

Indeed, Atlanta Signal Processors Inc. (ASPI) in Atlanta is one of the more than a dozen new third party software companies addressing this need. Founded in 1982 to provide consulting and develop algorithms, its founders soon realized the industry suffered a lack of DSP knowledge within the engineering base. As a result, "for the next four to five years, our big role will be in creating development tools . . . encapsulating DSP design tools in CAD [computer-aided design] systems," says Thomas P. Barnwell, co-founder and vice president of engineering at ASPI.

In addition to design tools, test equipment for DSPs is also lacking. "There's a new class of tools that's missing," Barnwell points out. "For signal processing, algorithms require a level of testing that isn't simply verification. What's missing is the ability to effectively run real-time debugging [nonintrusively]."

From a customer's point of view, says John Ekiss, president and chief executive officer of Santa Clara-based Zoran Corp., there have been so many products introduced over the last 12 months, and so many claims being made, that there is a great deal of customer confusion. Ekiss also realizes that as long as confusion reigns, the cash register will not ring. And so, Zoran is "plugging away at the fundamentals, trying to educate customers [with] training courses, seminars and published materials."

Lack of education in the complexities of digital signal processing is a complaint of many DSP component vendors. But this weak spot seems to be affecting the lower end of the market rather than the high end. According to Christopher Ryan, DSP product marketing manager for Plessey Semiconductor in Britain, at the top end, where Plessey is focused, "engineers involved in radar, sonar and video processing know what they're doing."

In time, as current obstacles are resolved, new ones are expected to arise. "Five years from now the limitation will be an inability to design devices," says Honeywell's Stjernquist. Within 10 years, Stjernquist believes, there will be a market for one million gates per chip. The issue then will be how to design and manufacture the complex chip.

COST OF ENTRY

Becoming a contender in the DSP arena can cost less than $10 million or more than $50 million. The smaller the budget size, however, the more likely a company will choose high-end, niched segments. Companies earning only a few million dollars a year are anxious to avoid head to head confrontations with semiconductor Goliaths who spend more in a month on research and development (R&D) than the start-up Davids have to spend on an entire year's operating budget. (For example, AMD spent $164 million on R&D, their fiscal year ending March 1985. Texas Instruments spent $402 million in their fiscal year ending December 1985 [ELECTRONIC BUSINESS August 1, 1986 p92]. On the other hand, Weitek Corp. has raised a total of $7 million in venture capital since being founded in 1981 and the company still has $4 million of that in the bank.)

Ted Dintersmith, division general manager of Digital Signal Processing Inc., an internal division of Analog Devices, estimates that for a full-blown DSP start-up the costs are "certainly in the $50 million range." A new wafer fab facility might cost in the tens of millions of dollars, he estimates. In addition, a base of computer-aided design equipment can run into several million dollars and test equipment can run $2 million to $5 million "just to get going," says Dintersmith. At DSP Inc., two Teradyne J series testers, with million-dollar price tags, are included in the fab's equipment catagory. In addition to the cost of the wafer fab, the CAD equipment and basic computers that have a lot of computational ability, Dintersmith points out additional cash is needed for the internal structure including staffing, research and development costs, marketing and management teams.

> The smaller the budget size the more likely a company will choose high-end, niched segments

Such expenses are out of the reach of companies like Weitek Corp. — a start-up that specializes in high-end, building-block DSPs. Since its incorporation in 1981, Weitek has raised $7.7 million in venture capital. Instead of building its own manufacturing facility, the company has opted to have others do it for them. This choice, however, has more to do with a business philosophy than with the lack of megabucks.

Suggesting that traditional semiconductor companies, "as structured, are nonviable," Weitek's Rizzo extols the benefits of subcontracting semiconductor manufacturing. Rather than having to worry every year about coming up with large amounts of revenue for fresh capital to invest in costly manufacturing equipment, Weitek spends most of its money on R&D, technology support and marketing. "We think it would be foolish to build a fab. Our unit volume doesn't support it, and we can get all the processing technology we need without investing in a fab," says Rizzo.

If $50 million is too hefty a sum, and contract manufacturing is not considered a viable solution, there is another way to become a DSP player. With less than a quarter of its $27 million raised in venture capital, start-up Zoran Corp. purchased a manufacturing facility out of bankruptcy, paying "25 cents on the dollar," says president and chief executive Ekiss. ☐

Top digital signal processor vendors

Worldwide shipments ($ millions)

Single-chip DSPs

	1986	1991
Texas Instruments	$64	$240
NEC	23	120
AT&T	0	54
Motorola	0	48
Analog Devices	0	36
Others*	7	101
Total	**$94**	**$599**

*Fairchild, Fujitsu, Hitachi, INMOS, Mitsubishi, National Semiconductor

Building-block components

	1986	1991
Analog Devices	$19	$50
Integrated Device Technology	19	47
Weitek	19	47
TRW	16	37
AMD	12	30
Others*	9	37
Total	**$94**	**$243**

*Bipolar Integrated Technology, Micro Power Systems, Stanford Telecommunications, Texas Instruments

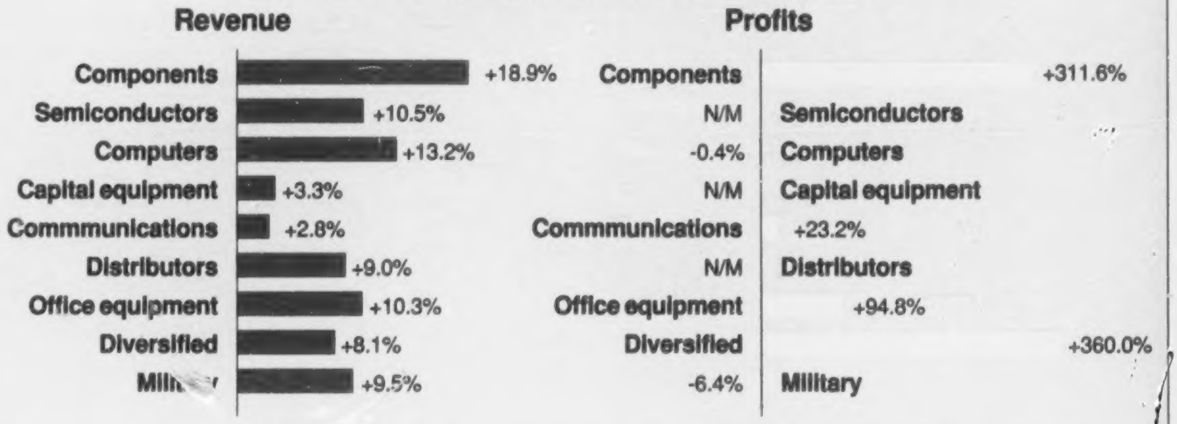
Source: Electronic Trend Publications

QUARTERLY SCORECARD

Financial results of leading U.S. electronics companies

Industry segment averages

Percentage change from 3rd quarter of 1985 to 3rd quarter of 1986



Components (Other than semiconductors)	Revenue 3rd quarter 1986 ($ millions)	Change from 1985	Profits 3rd quarter 1986 ($ millions)	Change from 1985	Revenue year-to-date 1986 ($ millions)	Change from 1985	Profits year-to-date 1986 ($ millions)	Change from 1985	Quarter ended
AMP	$481.4	+21.6%	$42.1	+94.8%	$1,426.7	+16.8%	$118.0	+37.1%	Sept. 30
AVX	$47.2	+12.9%	$0.4	N/M	$144.8	+6.6%	-$2.1	N/M	Sept. 28
Augat	$66.5	+5.5%	$2.5	-13.2%	$195.9	+2.8%	$7.0	-34.8%	Sept. 30
CTS	$62.0	-3.1%	$0.4	-66.6%	$180.0	-13.2%	-$2.3	N/M	Sept. 28
Molex	$93.0	+50.9%	$10.8	+72.8%	$257.7	+35.7%	$29.4	+39.6%	Sept. 30
Oak Industries	$34.7	+3.3%	-$4.2	N/M	$109.2	-4.5%	-$26.4	N/M	Sept. 30
Segment composite	$784.8	+18.9%	$52.0	+311.6%	$2,314.3	+12.4%	$123.6	+44.7%	

Semiconductors

Advanced Micro Devices	$157.7	+23.1%	-$46.9	N/M	$465.0	-3.1%	-$86.2	N/M	Sept. 28
Intel	$324.1	+4.0%	-$114.2	N/M	$909.4	-13.1%	-$156.7	N/M	Sept. 30
International Rectifier	$37.9	+8.0%	-$1.4	N/M	$113.1	+6.4%	-$4.7	N/M	Sept. 30
LSI Logic	$46.5	+34.3%	-$1.3	N/M	$139.8	+41.9%	$2.1	-66.1%	Sept. 30
National Semiconductor	$501.1	+22.6%	-$1.4	N/M	$1,221.2	-0.9%	-$47.9	N/M	Aug. 31
Texas Instruments	$1,248.9	+4.8%	$14.0	N/M	$3,638.3	-2.1%	$13.3	N/M	Sept. 30
Western Digital	$83.7	+33.0%	$8.2	+233.4%	$236.2	+44.6%	$22.3	N/M	Sept. 27
Segment composite	$2,399.9	+10.5%	-$143.0	N/M	$6,723.0	-1.7%	-$257.8	N/M	

Computers and peripherals

Amdahl	$220.0	-0.5%	$7.1	+24.6%	$629.6	+4.1%	$12.2	-18.4%	Sept. 26
Apollo	$100.4	+81.8%	$2.5	N/M	$270.8	+20.4%	$4.1	N/M	Sept. 30
Apple	$510.8	+24.7%	$32.9	+47.1%	$1,368.0	+12.1%	$97.0	+541.6%	Sept. 26
Burroughs*	$2,633.0	+127.2%	$52.9	+64.3%	$5,106.6	+43.5%	$145.1	+9.2%	Sept. 30
COMPAQ	$147.2	+11.8%	$8.7	+38.7%	$438.4	+26.1%	$26.7	+60.7%	Sept. 30
Control Data	$818.5	-8.5%	-$9.3	N/M	$2,443.1	-9.5%	-$38.3	N/M	Sept. 30
Convergent	$64.7	-44.9%	-$25.7	N/M	$228.4	-32.9%	-$28.4	N/M	Sept. 30
Cray Research	$136.6	+37.3%	$26.1	+36.8%	$458.5	+55.2%	$101.5	+59.6%	Sept. 30
Data General	$330.1	+10.2%	$4.6	+820.0%	$974.2	+7.6%	$4.6	+270.3%	Sept. 27
DEC	$2,038.5	+25.5%	$182.6	+152.5%	$6,142.5	+18.9%	$591.6	+123.7%	Sept. 27
Honeywell	$1,664.9	+6.1%	$32.4	-41.8%	$4,897.3	+6.5%	$94.7	-38.7%	Sept. 30
IBM	$11,910.0	+1.8%	$1,077.0	-26.9%	$34,305.0	+4.3%	$3,399.0	-12.3%	Sept. 30
Micropolis	$55.4	+151.2%	$4.9	+987.2%	$161.3	+174.8%	$13.1	+2,387.3%	Sept. 26
Prime	$221.9	+12.8%	$12.1	-20.6%	$629.2	+12.4%	$32.8	-18.7%	Sept. 30
Sun Microsystems	$91.6	+171.8%	$6.7	+570.0%	$225.8	+115.3%	$16.0	+151.7%	Sept. 26
Tandem	$220.6	+26.9%	$21.6	+94.2%	$597.7	+28.7%	$52.1	+156.2%	Sept. 30
Telex	$204.9	+19.1%	$19.4	+13.7%	$604.5	+19.3%	$54.4	+10.4%	Sept. 30
Segment composite	$21,369.1	+13.2%	$1,456.5	-0.4%	$59,480.9	+9.0%	$4,578.2	+4.3%	

* The latest quarter includes Sperry Corp.'s results as of September 16. Burrough's year-ago results do not include Sperry's year-ago results

N/M = not meaningful

Continued

QUARTERLY SCORECARD

Financial results of leading U.S. electronics companies

Capital equipment	Revenue 3rd quarter 1986 ($ millions)	Change from 1985	Profits 3rd quarter 1986 ($ millions)	Change from 1985	Revenue year-to-date 1986 ($ millions)	Change from 1985	Profits year-to-date 1986 ($ millions)	Change from 1985	Quarter ended
Computervision	$125.9	+19.1%	$1.2	N/M	$358.2	+10.6%	-$9.2	N/M	Sept. 30
Fluke	$52.4	+0.5%	$2.9	-22.2%	$157.4	-3.5%	$9.0	-20.8%	Sept. 28
GCA	$31.7	+6.5%	-$3.1	N/M	$102.3	-24.5%	-$4.0	N/M	Sept. 30
GenRad	$45.0	-9.7%	-$8.7	N/M	$142.8	-15.3%	-$28.4	N/M	Sept. 30
Spectra-Physics	$54.8	+0.9%	-$0.9	N/M	$160.1	+7.5%	$0.7	N/M	Sept. 30
Tektronix	$304.9	+0.8%	$14.6	+321.6%	$1,032.2	-5.9%	$37.7	-34.3%	Aug. 23
Teradyne	$83.0	+6.2%	$0.0	-94.3%	$232.5	-11.4%	$0.2	-99.2%	Sept. 30
Varian	$236.3	+1.9%	-$11.5	N/M	$693.4	-5.9%	-$16.6	N/M	Oct. 3
Segment composite	$934.0	+3.3%	-$5.5	N/M	$2,878.9	-5.2%	-$10.6	N/M	
Communications									
Andrew	$61.0	+5.8%	$3.2	-31.7%	$149.3	-6.3%	$7.2	-27.1%	Sept. 30
Aydin	$32.0	+1.3%	$1.7	+97.7%	$102.4	+4.7%	$5.4	+88.0%	Sept. 27
DSC Communications	$70.8	+4.0%	$3.0	N/M	$229.5	+9.0%	$8.7	N/M	Sept. 30
Dynatech	$72.2	+7.6%	$6.0	+8.7%	$205.3	+8.4%	$17.0	-3.0%	Sept. 30
General DataComm	$46.3	+8.3%	$0.9	+181.8%	$137.2	-1.3%	$2.4	-66.5%	Sept. 30
Micom Systems	$48.1	+2.1%	$2.8	+8.8%	$141.1	-2.8%	$6.1	-42.1%	Sept. 30
Northern Telecom	$1,030.0	+3.5%	$59.4	+1.7%	$3,070.0	-0.3%	$160.7	-15.4%	Sept. 30
Paradyne	$64.2	+11.1%	-$13.6	N/M	$197.4	+2.6%	-$12.6	N/M	Sept. 30
TIE/communications	$67.3	-20.3%	-$7.1	N/M	$234.3	-3.8%	-$13.3	N/M	Sept. 30
Segment composite	$1,491.9	+2.8%	$56.3	+23.2%	$4,466.5	+0.2%	$181.6	+10.5%	
Distributors									
Arrow Electronics	$127.6	+3.6%	-$8.9	N/M	$397.1	-4.2%	-$21.5	N/M	Sept. 30
Avnet	$363.1	+7.3%	$6.0	-20.0%	$1,100.6	+5.3%	$14.0	-44.2%	Sept. 26
Ducommun	$111.1	+11.4%	-$0.8	N/M	$347.8	+12.8%	-$0.5	N/M	Sept. 26
Marshall Industries	$70.5	+24.8%	$1.1	+518.9%	$202.5	+15.5%	$3.7	+178.6%	Aug. 31
Pioneer-Standard	$54.6	+11.8%	$0.2	N/M	$159.8	+3.0%	-$0.7	N/M	Sept. 30
Segment composite	$726.9	+9.0%	-$2.4	N/M	$2,207.8	+5.2%	-$5.0	N/M	
Office equipment									
Diebold	$100.4	+5.3%	$7.2	+32.2%	$303.7	+1.4%	$24.9	+24.7%	Sept. 30
NBI	$72.1	+3.1%	-$1.3	N/M	$213.3	+12.5%	-$6.4	N/M	Sept. 30
NCR	$1,176.9	+13.4%	$73.4	+2.3%	$3,306.5	+13.6%	$202.5	+11.3%	Sept. 30
Pitney Bowes	$495.3	+11.6%	$38.9	+18.6%	$1,423.3	+9.1%	$112.2	+20.6%	Sept. 30
Wang	$597.9	+6.6%	-$30.0	N/M	$2,000.0	+14.4%	-$7.8	N/M	Sept. 30
Xerox	$2,316.0	+9.9%	$112.0	N/M	$6,632.0	+7.6%	$335.0	+5.0%	Sept. 30
Segment composite	$4,758.6	+10.3%	$200.2	+94.8%	$13,878.8	+10.0%	$660.4	+23.1%	
Diversified									
General Instrument	$206.7	+10.0%	$3.0	N/M	$609.7	+1.0%	$13.4	N/M	Aug. 31
Gould	$227.4	-1.2%	$4.3	-72.6%	$681.4	-1.2%	$29.1	N/M	Sept. 30
Harris	$477.6	-15.2%	$16.3	+26.1%	$1,572.1	-10.1%	$48.5	+4.9%	Sept. 27
Motorola	$1,431.0	+10.0%	$31.0	N/M	$4,269.0	+6.9%	$131.0	+367.9%	Sept. 27
N.A. Philips	$1,084.3	+4.4%	$17.4	+29.9%	$3,175.6	+3.5%	$20.9	-61.9%	Sept. 30
Tandy	$742.6	+14.1%	$43.7	+4.8%	$2,126.8	+14.5%	$118.4	+0.7%	Sept. 30
Zenith	$513.8	+42.4%	$3.9	N/M	$1,295.0	+13.6%	-$10.4	N/M	Oct. 4
Segment composite	$4,683.4	+8.1%	$119.6	+360.0%	$13,729.6	+4.8%	$350.9	+372.8%	
Military									
E-Systems	$283.8	+17.8%	$16.4	+21.3%	$834.1	+21.6%	$46.7	+5.4%	Sept. 30
Electrospace Systems	$46.2	+33.0%	$0.9	-70.0%	$133.4	+38.6%	$7.4	-18.0%	Oct. 3
Hazeltine	$24.5	-41.9%	-$1.8	N/M	$85.6	-28.8%	-$5.4	N/M	Sept. 30
Logicon	$51.6	+1.6%	$2.2	-14.6%	$155.4	+11.4%	$7.1	-1.7%	Sept. 30
Loral	$157.5	+4.2%	$12.9	+5.5%	$518.4	+19.0%	$43.3	+20.9%	Sept. 30
Raytheon	$1,714.0	+9.6%	$101.5	+6.5%	$5,267.0	+12.2%	$293.6	+5.9%	Sept. 28
Tracor	$153.0	+12.5%	-$3.1	N/M	$460.8	+14.3%	$11.1	-47.4%	Sept. 30
Watkins-Johnson	$63.2	+9.6%	$4.3	-10.9%	$190.9	+10.8%	$13.7	+10.9%	Sept. 26
Segment composite	$2,493.8	+9.5%	$133.3	-6.4%	$7,645.6	+13.3%	$417.5	+0.6%	

N/M = not meaningful

Source: Dow Jones News/Retrieval

LEADTIME INDEX

Electronic component leadtimes

Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average	Last month's average
TRANSFORMERS								
Toroidal	12	29	24	35	0	0	8.1	8.5
Pot-Core	11	34	33	22	0	0	6.9	7.3
Laminate (power)	6	25	31	38	0	0	9.0	8.9
CONNECTORS								
Military panel	40	20	40	0	0	0	3.6	13.8
Flat/Cable	28	39	33	0	0	0	3.4	4.6
Multipin circular	12	50	35	0	0	0	4.5	7.4
PC	6	65	12	17	0	0	5.1	7.1
RF/Coaxial	40	50	10	0	0	0	1.8	5.4
Socket	28	33	28	11	0	0	4.7	5.3
Terminal blocks	17	50	28	5	0	0	4.1	6.3
Edge card	19	31	31	19	0	0	6.1	5.9
Subminiature	18	39	36	9	0	0	5.1	7.3
Rack & panel	14	29	28	29	0	0	7.4	9.8
Power	0	50	50	0	0	0	5.0	8.2
PRINTED CIRCUIT BOARDS								
Single-sided	0	52	48	0	0	0	4.9	5.1
Double-sided	0	48	52	0	0	0	5.1	5.0
Multilayer	0	15	85	0	0	0	7.1	9.0
Prototype	4	91	5	0	0	0	2.2	3.0
RESISTORS								
Carbon film	44	37	19	0	0	0	2.2	3.6
Carbon composition	24	48	17	7	0	0	4.0	4.3
Metal film	36	27	32	5	0	0	3.8	3.8
Metal oxide	17	33	42	8	0	0	5.3	4.9
Wirewound	11	21	53	10	5	0	7.7	5.1
Potentiometers	9	37	17	35	0	0	7.7	5.5
Networks	30	40	20	0	5	5	5.2	6.0
FUSES	40	35	25	0	0	0	2.7	2.1
SWITCHES								
Pushbutton	6	50	33	11	0	0	5.4	6.4
Rotary	0	47	41	12	0	0	6.1	8.2
Rocker	18	41	35	6	0	0	4.6	5.8
Thumbwheel	0	45	33	11	11	0	8.2	6.8
Snap action	9	46	27	9	9	0	6.9	5.3
Momentary	0	57	29	14	0	0	5.7	6.4
Dual in-line	0	57	29	14	0	0	5.7	6.2
WIRE AND CABLE								
Coaxial	44	44	12	0	0	0	1.9	3.2
Flat ribbon	53	21	26	0	0	0	2.5	4.5
Multiconductor	60	27	13	0	0	0	1.6	5.3
Hookup	50	42	8	0	0	0	1.5	3.7
Wire wrap	36	50	14	0	0	0	2.1	3.4
Power cords	36	32	28	4	0	0	3.5	5.4
Other	33	0	67	0	0	0	5.3	6.0
POWER SUPPLIES								
Switching	0	46	54	0	0	0	5.2	9.3
Linear	7	43	50	0	0	0	4.8	7.3
CIRCUIT BREAKERS	14	29	50	7	0	0	5.7	6.8
HEAT SINKS	23	45	32	0	0	0	3.5	4.5

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average	Last month's average
RELAYS								
General purpose	27	33	20	20	0	0	5.5	6.3
PC board	8	46	15	31	0	0	7.1	8.5
Dry reed	0	33	34	33	0	0	8.7	9.2
Mercury	0	60	20	20	0	0	6.0	8.4
Solid state	27	36	9	10	18	0	7.6	10.0
DISCRETE SEMICONDUCTORS								
Diode	32	44	16	8	0	0	3.4	4.8
Zener	28	28	33	11	0	0	5.0	5.9
Thyristor	38	25	25	12	0	0	4.5	8.0
Small signal transistor	20	40	27	13	0	0	5.1	7.0
FET, MOS	9	27	46	18	0	0	7.1	8.9
Power, bipolar	22	22	33	22	0	0	6.7	7.6
INTEGRATED CIRCUITS, DIGITAL								
CMOS	10	58	21	11	0	0	4.5	7.8
TTL	13	50	31	6	0	0	4.5	6.5
LS	21	47	21	11	0	0	4.3	6.7
INTEGRATED CIRCUITS, LINEAR								
Communication/circuit	25	50	12	13	0	0	4.0	8.9
OP amplifier	4	45	27	14	5	0	6.5	6.9
Voltage regulator	19	50	19	12	0	0	4.5	5.4
MEMORY CIRCUITS								
RAM 16k	30	30	30	10	0	0	4.6	6.1
RAM 64k	42	25	17	16	0	0	4.5	5.3
RAM 256k	10	50	20	20	0	0	5.8	6.0
ROM/PROM	25	25	17	33	0	0	7.2	7.7
EPROM	27	33	20	20	0	0	5.5	5.4
EEPROM	11	33	22	34	0	0	7.8	6.4
DISPLAYS								
Panel meters	18	27	27	28	0	0	7.1	7.7
Fluorescent	0	25	50	25	0	0	8.5	10.0
Incandescent	0	20	50	20	0	0	8.4	10.3
LED	14	38	43	5	0	0	4.9	5.6
Liquid crystal	12	37	13	38	0	0	7.8	8.5
MICROPROCESSOR ICs								
8-bit	18	27	27	28	0	0	7.1	7.6
16-bit	13	62	13	12	0	0	4.3	9.1
FUNCTION PACKAGES								
Amplifier	17	33	33	17	0	0	6.0	9.5
Converter, analog to digital	0	30	20	50	0	0	10.2	8.5
Converter, digital to analog	0	12	38	50	0	0	11.3	9.2
LINE FILTERS	9	46	36	9	0	0	5.3	8.5
CAPACITORS								
Ceramic	31	31	21	17	0	0	5.0	6.3
Ceramic monolithic	31	21	32	16	0	0	5.5	5.9
Ceramic disc	30	35	25	10	0	0	4.3	6.5
Film	27	36	28	9	0	0	4.4	6.7
Electrolytic	17	29	37	17	0	0	6.3	5.8
Tantalum	17	27	37	17	0	0	6.3	7.2
INDUCTORS	14	38	43	15	0	0	6.3	6.8

Source: *Electronics Purchasing* magazine's survey of buyers

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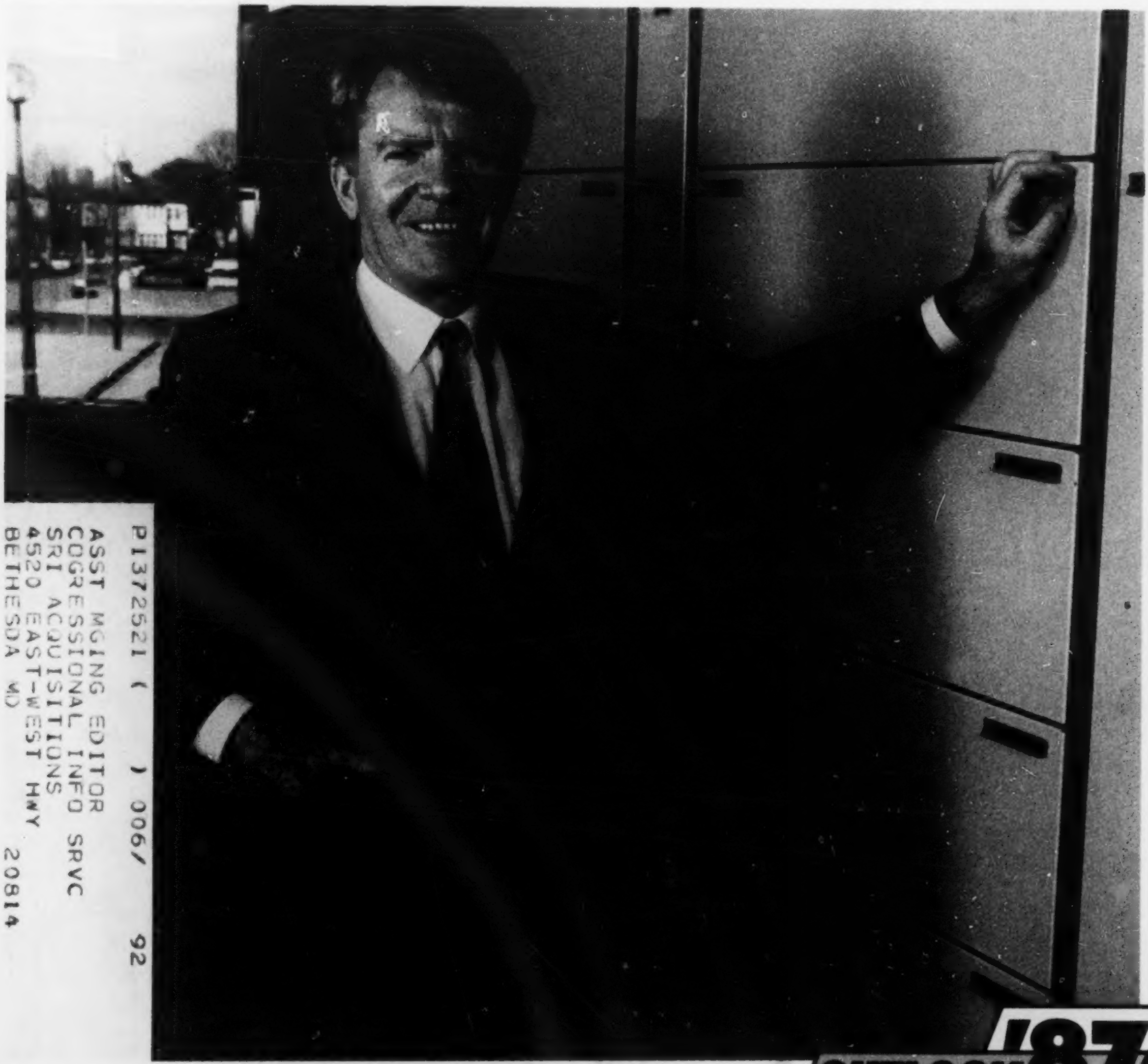
Electronic Business

Image processing's picture-perfect opportunities

CASE: The growing market for software that writes software



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OUTLOOK '87

Plessey's David Dey: The sun shines on a $2 billion empire

Electronic Business

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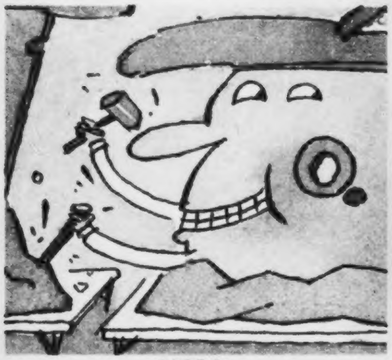
THE BUSINESS MAGAZINE FOR THE ELECTRONICS INDUSTRY



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But, new applications are expected to come soon.

33 The patent has expired, but vital signs are stable
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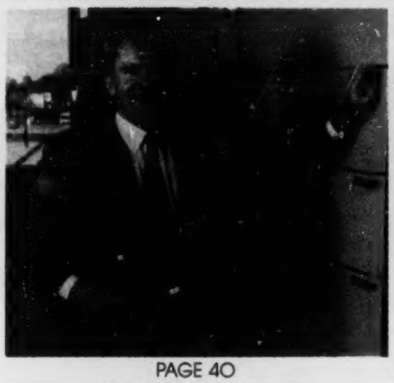

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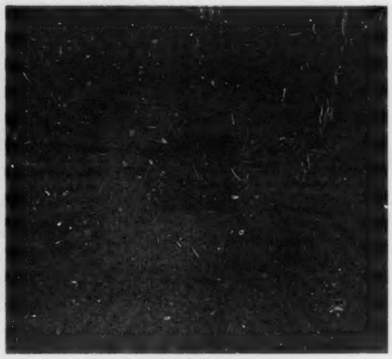
Britain's No. 2 electronics manufacturer resisted being swallowed by GEC. What's next?

48 Sequent's secret: Evolve with the marketplace
When Casey came to bat, he aimed at technical sales. But OEMs and resellers also wanted to play.



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BPA ABP

Last quarter's profits may set the tone for 1987

Key to profits for this year are a recovery in demand for chips accompanied by firm prices

For the ELECTRONIC BUSINESS index for revenue, 1986 had the dubious distinction of registering the slowest growth in the past 10 years. Still, growth there was, so the index reached its highest level ever. For the profits index, however, the picture was far more negative. It was the first time in 10 years, the period the magazine has kept track of the activity by electronics companies, that this index declined from the previous year.

The profits index had already started 1986 on a very low note, by sliding in the first quarter to its lowest level in three years, but it may have ended the year on its way up, as the cost cutting measures many companies have implemented show their impact on the bottom line. The challenge for management in 1986 was to make their companies leaner without cutting into the bone. To bring cost, which was bloated from the expectation of higher business levels, in line with actual revenue while at the same time providing for future growth. "Our most important goal [for 1987] is to add to profits and improve [their] consistency," says Jerry R. Junkins, president and chief executive of Texas Instruments Inc.

This company, which derives its revenue from semiconductors, defense electronics, computers and oil exploration, provides a good example of the ills that affected the electronics industry in the past two years and of the opportunity for overcoming them. Semiconductors still are not profitable, but TI has been cutting losses and expects a profitable year in 1987. Profits for defense electronics have been stable all along. For computers, they turned from red to black in 1986. Oil exploration, on the other hand, has moved in the opposite direction, driven by low oil prices.

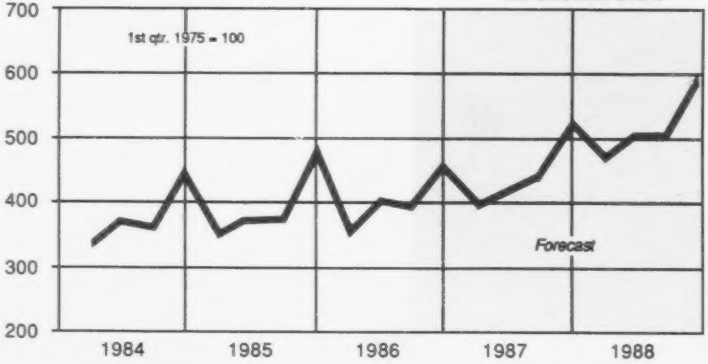
Other companies which, along with TI, are among the 16 that this magazine tracks to build the ELECTRONIC BUSINESS indexes for revenue and profits, have behaved similarly. Chip makers Advanced Micro Devices Inc. (AMD) and Intel Corp. have seen their bottom lines worsen through the first three quarters of 1986 but expect that cost controls and improving semiconductor sales have cut losses in the last quarter and will put them in the black for 1987. Texas-based defense electronics contractor E-Systems Inc. has been, in 1986, consistently profitable and ahead of 1985. Computer manufacturers are a mixed bag. They were profitable in 1986, but their balance was heavily upset by IBM's eroding bottom line. Digital Equipment Corp., buoyed by the success of the MicroVAX addition to its already successful VAX line of minicomputers, turned in a sterling profit performance last year, and expects to continue doing so in this one. Profits at Hewlett-Packard Co. and Honeywell Inc. held even but low in 1986 and may not improve much in 1987.

Cahners Economics estimates that revenue grew only 2% while profits lost 6% in 1986. Economist Cheryl Patstone forecasts that both indexes will make parallel gains in 1987 — 11% for revenue, 12% for profits. Such performance would depend heavily on the same factor that AMD, Intel and TI hope for; a recovery in the demand for semiconductors accompanied by firm prices for chips.

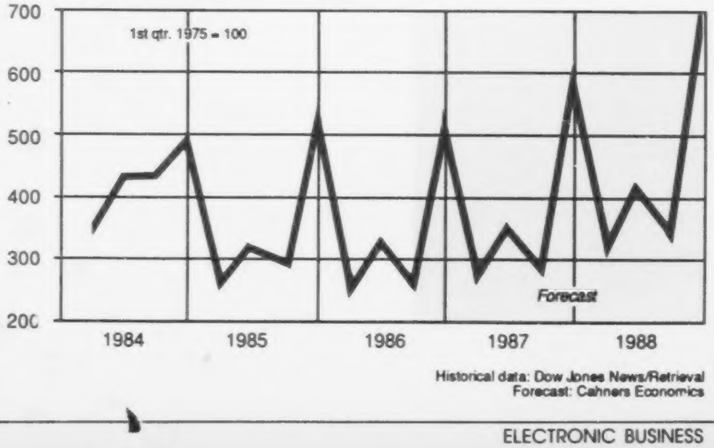
ALBERTO SOCOLOVSKY

Electronic Business

Revenue index



Profit index



Historical data: Dow Jones News/Retrieval
Forecast: Cahners Economics

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, showed a mild decline in the second quarter, followed by a slight recovery in the third quarter. For the year, production is expected to be up a scant 0.9% from last year. Next year, steady improvements are forecast thoughout the year pushing production up 3.9% in 1987.

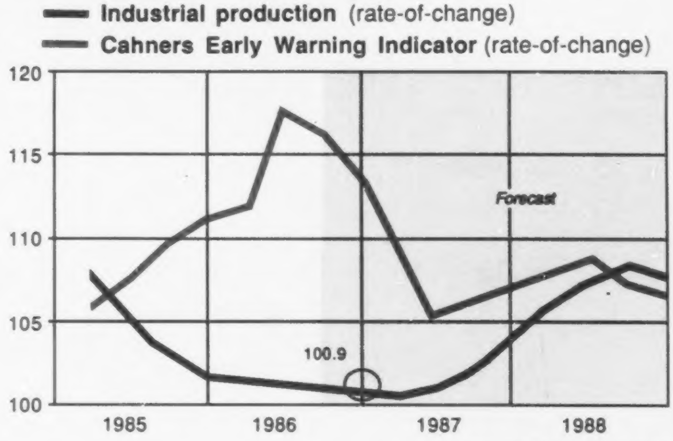
The Cahners Early Warning Indicator (CEWI) is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index. It forecasts probable business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 100.9 level forecasts using the CEWI for the end of this year indicates that the average for all of 1986 should be 0.9% above 1985.

Readers can obtain a brochure explaining the CEWI method from Cheryl Patstone, economist, Cahners Economics Department, 3021 Tisch Way, Suite 100, San Jose, Calif. 95128.

ATE revenue and profit

In the third quarter of 1986, revenue for automatic test equipment manufacturers showed an 8% increase from the prior quarter and was up 9% from the year-ago quarter. This was the first quarter-to-quarter gain since the beginning of 1985. The gradual improvement in the third quarter along with fourth quarter revenue expected to show an even sharper increase, when demand from computer and semiconductor manufacturers for automatic test equipment strengthens, seems to signal a climate of cautious expansion. Following a strong 42.4% gain in 1984, sales fell 14.4% in 1985. Despite a gradual improvement in the second half of 1986, revenue is expected to drop 2.7%. This year a 12.2% increase is forecast, followed by a sharp 25.3% rise in 1988. Earnings of ATE manufacturers showed a slight profit for the first time in over a year. Profits are expected to continue to strengthen through the next two years.

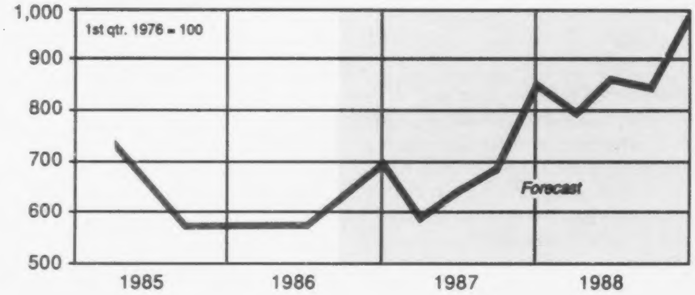
Economic indicators



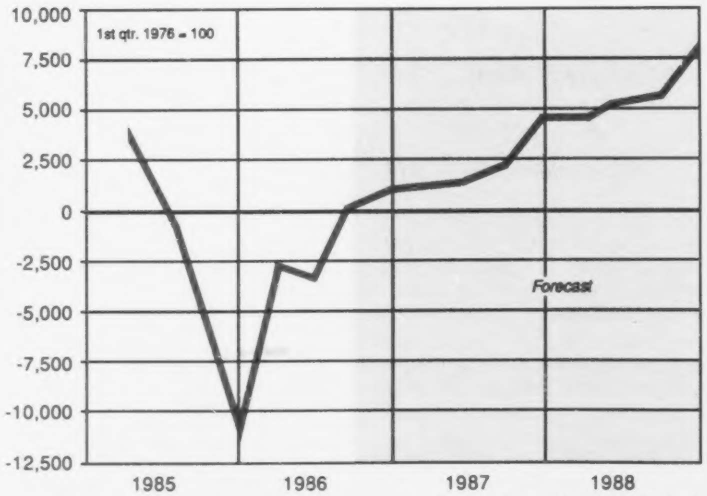
Historical data: Federal Reserve Board
Forecast: Cahners Economics

ATE indexes

Revenue



Profits



Historical data: Dow Jones News/Retrieval
Forecast: Cahners Economics

LETTERS

Insightful thanks

Just a note to say how much I enjoyed your article on Toshiba in last week's ELECTRONIC BUSINESS [Sept. 1, p46]. Your insight into their strategy in computers and their tactical response to the current challenges of the rising yen and dumping charges was very stimulating.

Thanks for an excellent overview on a key strategic customer/competitor/partner for Hewlett-Packard.

RICHARD C. WATTS
Marketing Manager, Design Systems Group
Hewlett-Packard
Fort Collins, Colo.

A secure correction

I am writing to correct an error in your recent story on security system markets [ELECTRONIC BUSINESS, Oct. 15, p106]. In fact, U.S. demand for X-ray inspection equipment, metal detectors and bomb detectors in 1985 was closer to $60 million. Further, growth in demand through 1990 will be just over 17% annually.

AMADEE BENDER
President
Worltech Reports
Northport, N.Y.

An American product

I very much enjoyed your article on PC compatibles in the August 15th issue, ["PCs: Turning back the Far East tide," p48] as my company is part of this exciting industry. However, I must take issue with two items.

First, it's ironic that you chose PC's Limited as an example of American manufacturing, since they made their name importing low-end Taiwanese products. I examined their turbo computer, and found a Japanese motherboard and a Taiwanese case and power supply. I don't believe Mr. Dell does more than final assembly in the U.S.

Second, I perceived a little bit of "hooray, we're beating Japan" in the article. A more compelling question is domestic vs. imported in general. Consider switching power supplies (a small circuit board with few parts) as an example. It doesn't appear to be sensitive to labor costs, yet the Taiwanese can sell me a 130-watt model for $50. The U.S. makers want upward of $100!

I must conclude that the Taiwanese pay less than we do for all their components. I've been told by Taiwanese makers that their costs for Texas Instruments TTL chips are lower than my cost in the U.S. I would like to see an article on component pricing in the various countries.

By the way, Proto PC manufactures a truly U.S.-made XT motherboard. Our XT16 uses high-tech parts from VLSI Technology, Standard Microsystems and NCR (on-board DRAM, Floppy and SCSI controllers) and is a very fast, extremely high-quality product.

RICHARD HAGER
President
Proto PC Inc.
St. Paul, Minn.

A calculated defense

I just finished reading the listing of the top 40 defense contractors in the August 15 [p90] issue of ELECTRONIC BUSINESS. I'm not sure if the omission occurred on your side or our side, but Control Data Corp. should have been included in your listing.

All of the relevant information is available in a recent prospectus, which I have enclosed for you (the appropriate segments are marked). With a few simple calculations, it's easy to see that Control Data's defense business resulted in approximately $330 million in revenue in 1985. This number clearly adds us to your top 40 listing.

KATHRYN J. WARDROP
Manager Corporate Public Relations
Control Data Corp.
Minneapolis, Minn.

Rave review

I just read your interesting memo in the October 15 issue [p9] of ELECTRONIC BUSINESS and would like very much to receive your list of Japanese firms' planning investments for overseas production.

One question. Being from a Business Analysis group at a semiconductor manufacturing plant, my interests are naturally oriented toward that market. Do you see the same opportunities existing, as mentioned in your memo, for the semiconductor market in Japan? Or is any potential opportunity in that market negated by the adverse (to the U.S.) effects of the antidumping pact between the U.S. and Japan? What are your thoughts?

In my job as Information Resources Analyst I read and review many of the electronics and business magazines on the market today and critique (abstract) articles of relevance to competitiveness in the electronics industry that have bearing to the computer and semiconductor fields. I find your magazine both relevant and insightful, and look forward to reading it every other week. Keep up the good work.

MARK A. DESROSIERS
Business Analysis
IBM Corp.
Essex Junction, Vt.

J. Chat Kelly, Vice President/Publisher responds:
Thank you for your letter responding to my article, "Where are the American companies."

Regarding the semiconductor manufacturers, the future appears to be in developing strong and lasting partnerships between shores. The first to sign up after the trade agreements, where approved, was National Semiconductor and the Japanese foundry, NMB. The Fujitsu/Fairchild merger is another example.

I submit that in five years it will be difficult to distinguish between a Japanese and American semiconductor industry; it will be a global industry with manufacturing and design facilities located near the customer to provide the most important product attribute — service.

Corrections

In the story "Military ATE: Here comes the 'Mod Squad'" [Oct. 1, p62], General Electric Co.'s partners on the Navy test system bid were misidentified. GE is teamed with Astro Systems Inc., Honeywell Inc. and Northrop Corp.

In the article "National strategies for regional distributors" [Oct. 15 p75], the correct spellings are Gordon Taplinger and Herbach & Rademan.

Letters to the editor

ELECTRONIC BUSINESS welcomes letters to the editor on any topic of interest to our readers. If not written on organizational letterhead, all letters must include a telephone number. ELECTRONIC BUSINESS reserves the right to edit letters.

ELECTRONIC BUSINESS
Cahners Building
275 Washington Street
Newton, Mass. 02158

A slowdown in orders for fiber-optic cable

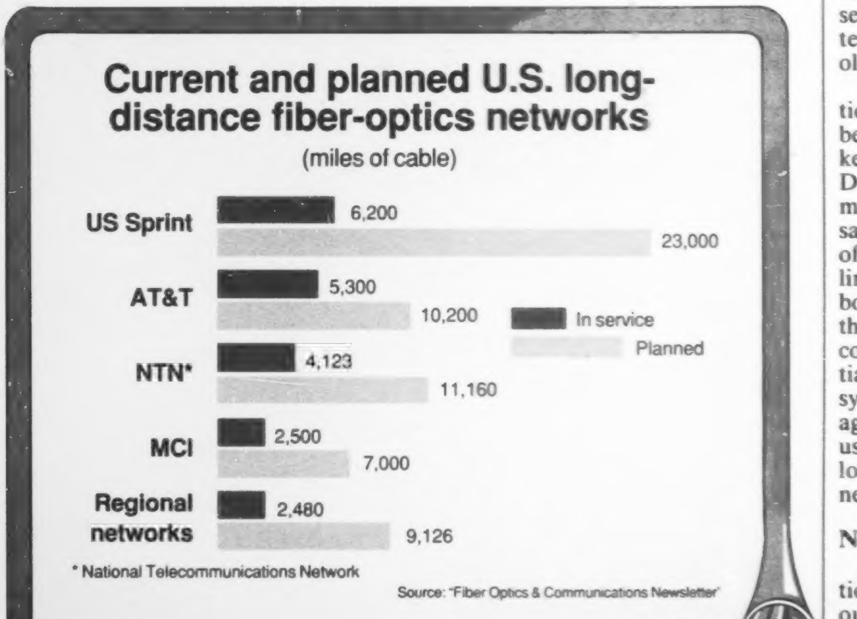
But, most vendors say that they are not worried because new applications are expected to come soon

Fiber-optic cable sales are losing some of their momentum as long-distance telephone companies draw closer to completing their domestic fiber networks. Although more than 40,000 miles of cable are scheduled to be laid in the next several years, no new, major orders have materialized. So the major players — AT&T, MCI Communications Corp., U.S. Telecom and the seven members of the National Telecommunications Network — have to be content with winding down their backlog of orders as they wrap up the last of their connections to domestic networks.

To date, 60,486 miles of cable are planned for the domestic market by the five largest carriers. About 20,603 miles of cable are now in service, according to the "Fiber Optics & Communications Newsletter." AT&T is also laying fiber optics across the Atlantic and Pacific oceans. With so much capacity becoming available, the long-haul companies are now hard at work trying to market the advantages of optical fiber to business customers.

Currently, fiber-optic technology permits a strand to move about 565 million characters of information a second. By 1988, that capacity is expected to reach 1.2 trillion characters a second, enough to allow a pair of cable strands to carry 16,000 voice conversations at once. More capacity will be reached when breakthrough equipment permits the movement of light signals in both directions at once on the same strand. In addition, the long-distance carriers foresee the need for more capacity in the future as telephone systems — and even high-definition television broadcast systems — are used more for data and video transmission. As a result, market research firms and fiber-optics companies alike claim that the current optical fiber cable slowdown is only temporary.

Order reduction has been felt by all of the biggest fiber-optics makers


Current and planned U.S. long-distance fiber-optics networks
(miles of cable)

* National Telecommunications Network
Source: "Fiber Optics & Communications Newsletter"

Still, the order reduction has been felt by all of the biggest fiber-optics makers. In November of 1985, for example, AT&T laid off 184 workers in the fiber-optics division of its giant Norcross, Ga., plant. That was followed by an August, 1986 layoff of 206 employees in the optical fiber and cable division. The plant employs about 3,700 and about 60% of the facility's capacity is devoted to fiber optics, the remainder is copper wire.

"There has been a lot of consolidation in the long-haul telephone business," says J.A. Jeffries, manager for AT&T's lightguide fiber and cable engineering operations at the company's Atlanta works. He says that some of the expected orders never materialized when long-distance companies combined their fiber-optic networks. But advances in the equipment used to transmit and receive optical signals have increased the capacity of fiber-optic cable, says Jeffries, and even greater strides are expected.

AT&T's competitors, particularly Corning Glass Works, have also noted a downturn in orders. The company reduced its fiber-optics workforce by 115 employees in 1986 and more layoffs are expected. Corning says that the slowdown in fiber-optics orders seems to be caused by a lag of local telephone companies replacing their old copper lines with fiber optics.

Both AT&T and Corning, the nation's largest producers of optical fibers, are trying to develop other markets for the medium. Charles W. Deneka, Corning's manager of new market development for fiber optics, says that Corning is looking at the use of optical fibers as communications lines between components or circuit boards in electronic equipment. Further out is the use of optics inside the computer chip itself. Another potential market is short-haul, underwater systems, across large lakes or archipelagoes, where repeaters (amplifiers used to boost optical signals during long-haul transmission) may not be necessary.

New applications

There are also potential applications within the telephone industry, outside the basic transmission of voice, data and video signals, says Peter A. Woog, AT&T's director of product management for media products at the Norcross works. "The next thing to come is photonic switching systems," Woog says, which are switching systems based on light signals instead of electromechanical or electronic techniques. Military uses are also being investigated. Currently under study, for example, are air-to-surface missiles attached to aircraft by optical fibers that spin off a reel when fired.

But all of the prospective uses have been slow in developing and they do not consume large quantities of optical fiber. Frank Dixon, president of Electronicast Corp. of San Mateo, Calif., believes that the need for fiber optics in local telephone systems will be the only market large enough to provide the sustained demand for fiber cables for a long time to come.

"There's been a leveling or slight drop in fiber-optic cable orders," Dixon says. He calls the slump a "slight aberration." Electronicast expects heavier usage of fiber-optic networks from the business sector to stimulate demand for local telephone companies to speed up installations. Total fiber-optic cable production for the U.S. market could reach 1.8 billion meters by 1990, Dixon says, up from the 492 million meters expected in 1986. And Business Communications Co., a market research concern, predicts a 16% growth in fiber-optics revenue between 1985 and 1995. Revenue, by 1995, is expected to meet $982 million compared with $227 million in 1985. Seventy percent of that market will be absorbed by the telecommunications industry, and electronics and other industries will buy the rest.

The big enchilada

"The local loop is the biggest market by far," says Deneka. "The big enchilada is the home, where [video-based] broadband switched networks will provide services such as high-definition television." Deneka says that such services, however, will not be available until the late 1990s. Some companies, though, are moving faster than others. Southern Bell Telephone and Telegraph Co., for example, which serves Georgia, Florida and the Carolinas, reports that by the end of 1986, the company had expected to install cables containing 186.3 million meters of fiber. For the past year this telephone utility, one of two operating companies owned by Atlanta-based BellSouth Corp., had been installing a higher capacity, single-filament fiber.

Besides connecting some business customers with fiber, as well as installing some trunk lines in major cities in its service area, Southern Bell is also currently studying residential installation. A large subdivision in Orlando, Fla., already has been hooked up to cable as part of a Southern Bell experiment.

"Fiber optics is just like any other technological breakthrough," explains Dixon of Electronicast. "There are applications we don't know about right now." One potential market would be the delivery of high-definition, digital television, he says. Such televisions would require a transmission line capacity of 140 megabits per second for each channel.

"Nothing can do that but fiber," Dixon says.

ROBERT SNOWDEN JONES

Jones is an Atlanta-based business writer

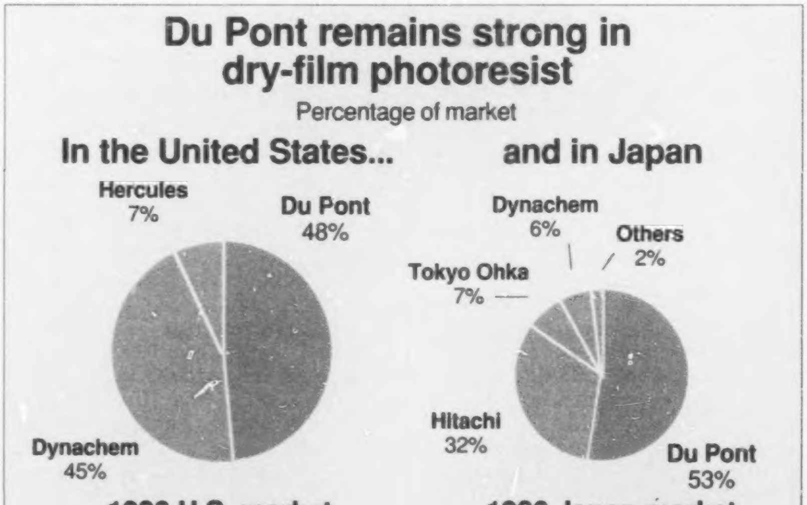
The patent has expired, but vital signs are stable

There is still life remaining in the dry film photoresist market. Postmortems on premier suppliers were premature

Before the 17-year-old Celeste patent held by E.I. du Pont de Nemours & Co. expired last fall, speculation ran rampant that a dozen new companies, mostly Japanese, would soon enter the U.S. dry film imaging market, valued anywhere between $120 million and $150 million. Heightened competition, the thinking went, would collapse prices and force Du Pont to exit the market.

To date no major part of this scenario has been played out. The U.S. market continues to be dominated by Du Pont with 48% market share and Morton-Thiokol Inc.'s Dynachem Division with 45%. Only Hitachi Ltd., among the Japanese players, has announced its intention of competing here. And only two or three other U.S. companies are serious about taking on Du Pont and Dynachem. Pricing, meanwhile, has held fairly steady at 26 cents to 28 cents per square foot of 1.5-mil film, although there are reports of giant customers such as AT&T or IBM purchasing dry film photoresist for under 20 cents because of their volume purchases.

Stable pricing and lack of new competition is due, in large part, to Du Pont's longevity in dry film photore-


Du Pont remains strong in dry-film photoresist

Percentage of market

Source: Gene Weiner & Associates Inc.

sist materials. When Du Pont scientist Jack Celeste, in 1969, patented the process of making printed circuit boards (PCBs) using dry film photoresist material — Riston in Du Pont's case — to image the circuit patterns, it represented the only technology for high-yield imaging of fine-line circuit boards.

The Du Pont patent was the foundation of the company's commercial success in printed circuits. Analysts estimate that Du Pont's Riston Products Division now controls 55% of the approximately $250 million worldwide dry film photoresist market. During the past two decades the giant chemical company has realized millions of dollars in revenue from royalties and licensing fees in connection with the dry film patent. Company officials estimate that Du Pont's annual sales reached $1.3 billion last year.

Mistaken judgement

"Many people misjudged the situation," Gene Weiner says of those that believed the patent's expiration would turn the market topsy-turvy. Explains the Danbury, Connecticut-based consultant and former Dynachem marketer: "Not only does it take a good product to enter this market, but to be truly competitive requires an enormous outlay in research and development and in technical service and support. . . . Du Pont and Dynachem have made major investments over many years and catching up to them is very difficult."

Service is especially important for material suppliers because their customer base is composed largely of little board shops that depend on their film suppliers for engineering help beyond the normal level of support. "This dependency makes it all the more crucial that the vendor be a highly capitalized company like Du Pont," says Nicholas Pearne, director at BPA Technology & Management Ltd., a British-based market research firm.

Worldwide currency fluctuations also are inhibiting new competition. In particular, the 50% appreciation of the yen since mid-1985 has made it uneconomical for potential Japanese competitors to manufacture dry film resist in their home market and ship it to the United States. Consultant Weiner estimates that the current cost of manufacturing a square foot of dry film photoresist in Japan is more than the average unit selling price in the States.

Couple the currency problem with the electronic industry's recession and the shakeout among U.S. merchant and captive PCB fabricators, says Weiner, and suddenly the dry film market has lost some of its allure to potential entrants.

The scorecard

The existing players in the worldwide market for dry film photoresist materials, besides Du Pont and Dynachem, include: Hercules Inc., Du Pont's big neighbor in Wilmington, Del., with an estimated U.S. market share of 7%; Hitachi, which has an estimated 32% of the Japanese market; and two European firms, BASF and Kalle, the latter a unit of Hoechst AG. But, neither European company has a significant share of its home market, nor are they taken seriously as global competitors.

Among the companies involved in dry film research and development (R&D) are an estimated seven to 10 Japanese firms, including Fuji, Mitsubishi Electric Corp. and Asahi Chemical; and two U.S. companies, the Christopher Group (a California startup founded by a former Dynachem executive) and Minnesota Mining and Manufacturing Co. (3M). The Christopher Group is reportedly looking for financing to bring its film to market, while 3M is said to be developing a positive dry film resist for niche applications for inner layer printing and etching. But, of all of these potential entrants, Fuji is widely seen as the most likely to have a future market impact.

Service is especially important for material suppliers because their customer base is composed largely of little board shops

James Hickman, marketing manager for the Riston Division of Du Pont, argues that even a new competitor with vast financial and technical resources will have trouble gaining immediate market share. Board shops, many of which are undercapitalized, are loathe to spend tens of millions of dollars to changeover their processes to accommodate new vendors.

Nevertheless, Hickman does not dismiss the long-term threat of the Japanese — particularly in the Far East, where the PCB industry is expected to experience its greatest growth. Mindful of the threat, Du Pont has launched a number of major dry film photopolymer R&D projects, including a technical venture with Lea Ronal Inc. to develop an automated PCB chemical plating process. The company, also, has doubled its dry film manufacturing capacity in the belief that the U.S. PCB market alone will grow 50% to 55% over the next four years to nearly $6 billion in 1990.

Dynachem also has major R&D programs in the works, including one project to use electrodialysis to control electroless copper baths in PCB manufacturing. The No. 2 dry film photoresist company does not feel threatened, however.

"After Celeste, it will be business as usual," says Daniel Feinberg, vice president of marketing and sales for Dynachem. Although he expects a handful of companies to filter in and out of the market as they have in the past, the Dynachem executive is confident that his company and Du Pont will continue to dominate the market.

"I know of only two ways a newcomer is going to gain market share in the U.S.," Feinberg says. "Either cut prices or deal with risky credit accounts. Those are not good long-term strategies."

Customer perspective

Users of dry film resist see the current U.S. market as a two-horse race. Bruce Sorensen, vice president for engineering at Diceon Electronics Inc., the fourth largest merchant PCB house with 1985 sales of $55 million, initially expected a flood of new competition in the wake of the Celeste patent's expiration. But he has changed his mind, explaining: "The market is too controlled for that to happen."

Dry film will continue to prevail over liquid photoresist materials, Sorensen predicts. "We don't see liquid imaging chemicals being a factor at all," he says. Although some analysts predict wet resists will comprise up to 20% of the market by 1990, most observers think liquid photoresist materials will have a major impact on solder masking, rather than on mainstream etching or plating applications.

Regardless of which technology prevails in the future, there is little doubt which one has been king of the hill in the past. Observes market researcher Pearne: "I don't believe you will ever see a patent so completely dominate a market the way Celeste did."

MARK MEHLER

Electronics in 1987: A reason to believe

Remember double-digit growth? Remember growth at all? Do not despair, you are now in the year of the turnaround

By Norm Alster

Although most economists view 1987 with only restrained enthusiasm, there is reason to believe the electronics industry will rebound strongly. Indeed, 1987 may prove to be a surprisingly good year for many sectors of the U.S. economy.

Improvement will be welcomed by manufacturers of electronic equipment. In 1986, troubled customers in the energy, banking and manufacturing sectors cut back on capital expenditures and U.S. production of commercial electronic equipment grew by just 2.9%, according to Henderson Ventures, a Los Altos, Calif., research and consulting firm.

When IBM chief executive John Akers attributed his firm's sales slump last year to weak capital spending, he was tacitly conceding the increasingly cyclical nature of the electronic equipment business. The industry is now so large, and its penetration of industrial and commercial life so thorough, that it can no longer achieve meaningful growth simply by expanding its applications or base of customers. Industry fortunes are ever more dependent on the broader cyclical patterns of the economy.

Edward Henderson, president of Henderson Ventures, believes that a strong 4.1% expansion in the U.S. gross national product will help trigger an industry turnaround this year. Although he expects military electronic equipment to grow by little more than 3% to $51.8 billion, Henderson expects U.S. production of commercial electronic equipment to grow by 13.4% to $140.8 billion. Henderson expects computer and office equipment to lead the way with 14.1% growth. The industrial and instrument sector (13.2%) and communications equipment (12.3%) should follow close behind. U.S. semiconductor consumption will reflect the revival, expanding by almost 22% after two weak years.

Henderson's vision of renewed double-digit revenue expansion is predicated on a somewhat optimistic outlook of the overall economy. Most economists are less sanguine. Four bellwether forecasts — from the Business Council, Data Resources Inc., the National Association of Business Economists and Wharton Econometric Forecasting Associates — all cluster around a projected 3% growth in GNP. Predictions of recession and boom are equally scarce.

> Industry fortunes are ever more dependent on the broader cyclical patterns of the economy

"Vigorous economic growth will elude us," the oracular Henry Kauffman, chief economist for Salomon Brothers, informed the Conference Board Inc.'s annual business outlook conclave in New York City. Kauffman and other economists are wary for a number of reasons. The U.S. budget deficit continues to siphon capital from productive investment. The merchandise trade deficit is as stubborn as it is large. The new tax reform legislation is expected to have "some dampening effect" on capital spending, in the words of Priscilla Luce, director of Wharton's industrial analysis service. And no one is quite sure that spendthrift consumers will continue to pile up record debts.

"The thing that does worry us is the level of consumer debt. Debt is very high. Saving is very low," says David Wyss, senior vice president with Data Resources. Encouraged by a series of tax cuts, the U.S. consumer has been a marvel of profligacy since 1983. As a result, total household liabilities now amount to 65% of the gross national product, according to Data Resources. In 1980, by contrast, they were 55% of GNP and in 1975, just 50% of GNP. "The average family owes over ten months of its disposable annual income," according to Wyss.

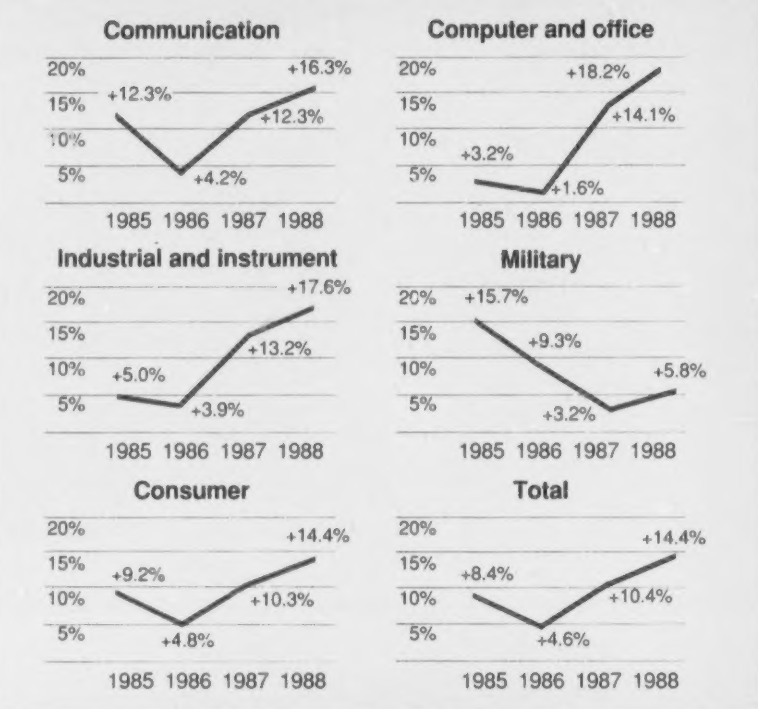
A sober outlook

If the consumer is suddenly overcome by fiscal sobriety, business is not considered likely to pick up the spending baton. For one thing, U.S. industry is operating at relatively low capacity, just under 80%. Historically, capital spending does not really kick in until industry is at 85% capacity utilization, according to Wyss. Also a depressant is the new tax legislation which lengthens depreciation schedules and eliminates the Investment Tax Credit (that allowed businesses to write off 10% of equipment purchases against their taxes). "In general, there's a slight bias against capital spending in the bill," says Wyss. DRI forecasts a 2.5% decline in capital spending in 1987.

The National Association of Business Economists is only slightly more optimistic, foreseeing a rise of less than 1% for the year. "There's concern that the implementation of the new tax law will be a mild depressant in early '87," reports NABE president

Electronic equipment

Annual growth in U.S. production



Source: Henderson Ventures

Electronic equipment

U.S. production ($ billions)

	1985	1986	1987	1988
Communication	$30.013	$31.286	$35.138	$40.869
Computer and office	58.051	58.957	67.244	79.477
Industrial and instrument	32.694	33.970	38.444	45.196
Military	45.896	50.160	51.759	54.782
Consumer	13.621	14.279	15.750	18.023
Total	**$180.275**	**$188.652**	**$208.335**	**$238.347**

Source: Henderson Ventures

Jerry Jordan, also senior vice president and chief economist with First Interstate Bancorp in Los Angeles, "but momentum will pick up as the year progresses."

Excising the worry warts

With consumer and business spending so problematic, some economists have trained their hopes for economic stimulation on the trade equation. This is the issue that truly separates the optimists from the worry warts. Pessimists argue that the devaluation of the dollar against the yen and key European currencies is simply not enough to improve the competitiveness of U.S. goods both inside and outside of the United States. They point out, moreover, that the dollar has not declined against the currencies of Korea, Taiwan and other trade rivals. These pessimists conclude that the trade deficit, which has shown only spotty signs of improvement, will endure since it reflects the abiding weakness of so many American firms in so many intensely competitive international industries.

Optimists contend that perspective is needed in discussing the gains of the Koreans and Taiwanese. They are simply not (economically speaking) as important as the Japanese and Europeans. Imports from the Pacific Rim nations represent just 14% of total U.S. imports. But imports from Japan and Europe — whose currencies have appreciated substantially in relation to the dollar — represent almost 40% of our whopping import bill. Already, says DRI, U.S. exporters are capitalizing on the currency situation in Europe. U.S. exports to the European Economic Community rose by 10.8% in the first seven months of 1986.

DRI's Wyss observes that it could be a mistake to write off the importance of currency shifts because the trade balance has not yet shown substantive response. "The history of the trade deficit has been that it tends to move later than people think. But when it does move, it moves very quickly." DRI expects the deficit to begin narrowing in 1987: down from last year's estimated $151 billion to a projected $133 billion.

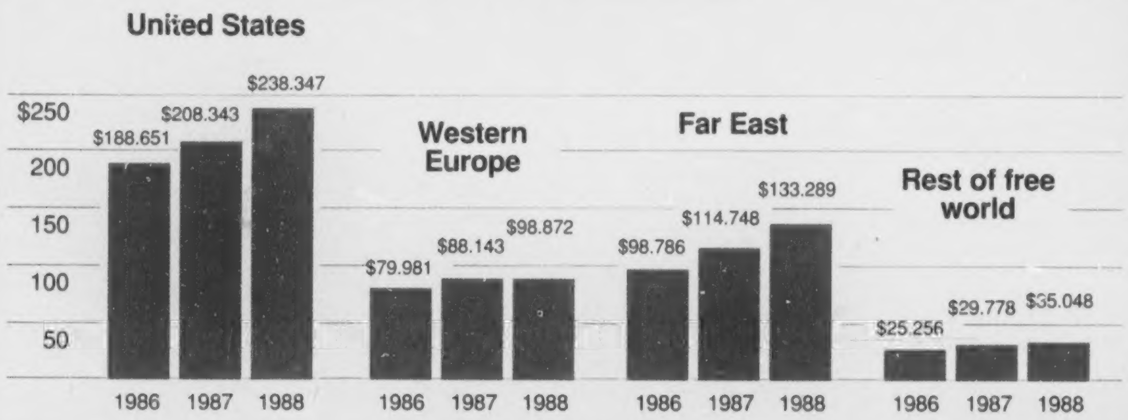
The turning point

Peter Fousek, executive vice president and director of research for the Federal Reserve Bank of New York, watches trade trends closely. He sees early-bird signs of improvement in such sectors as lumber, chemicals and pharmaceuticals. "I think the turning point is here," Fousek told assembled economists at the Conference Board (a nonprofit business research firm) meeting.

Reading the fine-lined tea leaves of trade is one thing. Acting wisely to capitalize on the trade situation is another. Many observers are concerned that U.S. firms will sacrifice potential long-term competitive gains for easy short-term profits. The Fed's Fousek, for example, found it "disturbing that domestic manufacturers are increasing prices." The point is that American manufacturers in electronics and other industries have an extraordinary opportunity to regain both domestic and international market share. But they must capitalize on the pricing problems of the Japanese to build presence in new markets and regain authority in old ones. In many sectors of the world, notes Elliot

Electronic equipment

Worldwide production ($ billions)



Source: Henderson Ventures

Riordan, manager of international consulting for Wharton Econometric Forecasting Associates, the competitive strength of the Japanese has shown significant deterioration. In Latin America and Australia, for example, currency and economic conditions favor a U.S. export offensive. "U.S. exporters should be very favorably positioned in Latin America," he adds, claiming that a recovering Brazil would prove an especially fertile area for U.S. exporters.

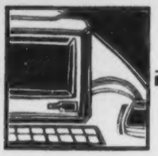
Henderson is convinced that trade will help catalyze economic expansion. "I think the net export situation should turn the economy around in 1987." Asked if this would include an improvement in the bilateral electronics trade deficit with Japan ($9.9 billion for the first six months of 1986, according to the American Electronics Association), Henderson replied: "Yes, I do foresee an improvement in the balance of trade with Japan." Indeed, with the Japanese themselves building production capability in the United States, he predicts a rather remarkable turn of events. By 1988, he says, the rate of growth in U.S. electronic equipment production "will probably exceed" the rate of growth of electronic equipment production in Japan.

Henderson also sees rekindled demand in domestic equipment and component markets. "I think there is the start of pent-up demand and kind of a desire to start kicking the tires on the new equipment." Crisper demand for equipment would translate into order momentum for component manufacturers. Lean inventories should also help. Last year, Henderson calculates, equipment makers were able to take $511 million of components out of their own inventories. This inventory drawdown actually represented almost 6% of total component usage. This year, says Henderson, OEM component inventories are "down to pretty much bare bones." He estimates inventories at 18 weeks; well below "normal" levels of 27 weeks. Thus, even if makers of computers, instruments and communications gear sell no more equipment than they did last year, their purchases of components should rise by 6%. Since Henderson expects U.S. equipment sales to rise by 14%, semiconductor consumption is expected to rise by 22%. Dataquest Inc. sees somewhat slower growth for electronic equipment — 11% for North America — and expects that North American semiconductor consumption will expand by 12% to $11.45 billion.

Too much optimism?

If optimism in today's economic environment seems unwarranted, think back a few years. The world economy was then hostage to an oil cartel that had raised the price of the industrial lifeblood by more than 800% in a decade. If you (and your bankers) had enough faith in your business to expand it, you could access capital at a prime rate running somewhere between 15% and 20%. The real value of profits was eroding at the rate of inflation: about 12% to 13% a year. And the Federal Reserve was so alarmed that it was willing (and able) to induce recession just to choke off inflation. With a yen/dollar equation of 230:1, it was U.S. manufacturers (and not, as is now the case, Japanese manufacturers) that were skimping on long-term investment and squeezing profits to adjust to pricing pressures.

Today, inflation has been subdued to its most temperate pace in 20 years. Money costs half of what it did. Oil costs even less. It is remarkable, really, that so many frightfully damaging and dangerous economic conditions have been reversed in the last two or three years. Sure, there is enduring cause for concern over budget and trade deficits each exceeding $150 billion. Sure, the tax bill will discourage some investment and the consumer may begin to notice he owes next year's wages. These are serious issues. But the truth is that the economy can never be squeezed into some ideal platonic form. It will always bulge or leak somewhere. That's why economists always have something to worry about. This may be one year, though, that it's worth looking beyond those worries. It's what economists have stopped worrying about that is really revealing. ☐



Computers: New names, new chips and $50.5 billion sales

The computer industry should show some modest growth in 1987. The technical segment will be the star performer

By Anne Knowles

The year of the 386. IBM's make-it-or-break-it year. The year of Unisys. A decade from now, 1987 may be remembered by the computer industry for any number of things, ranging from computers based on Intel Corp.'s 32-bit, 80386 microprocessor — commonly called the 386 — to newly formed Unisys Corp., the result of the merger of Burroughs Corp. and Sperry Corp.

The coming year will not be remembered as a year of phenomenal growth, though. In fact, according to most analysts, slower and more predictable expansion in the computer industry is here to stay. Stabilization started last year when computer shipments rose approximately 10%, according to market research firm International Data Corp., in Framingham, Mass. This year, predicts Dataquest Inc. of San Jose, Calif., the U.S. computer market will increase at about the same rate, from $46.2 billion to $50.5 billion. And IDC projects that computer shipments will continue to grow 10% annually for the remainder of the decade.

But some segments of the computer market are more equal than others. Sales of computers for technical applications — including computer-aided design and engineering, scientific research, and industrial automation — should remain robust, jumping 25% annually through 1990, says Hal Feeney, director of technical computer systems at Dataquest.

Meanwhile, 1987 revenue for computers shipped into business applications should rise only 4.7%, from $19.1 billion to $20 billion, says Van Weathers, Dataquest's director of business computer systems. That classification, says Weathers, includes systems spanning from mainframes to multiusers workstations, capable of handling two to 11 users.

Within that group, some size systems will fare better than other. Sales of corporate resource computers, or mainframes, will be nearly flat, hobbling up 1.5% from $6.7 billion to $6.8 billion, and their average selling price, predicts Weathers, will remain $3.5 million. What Dataquest calls a workgroup computer, equipped for two to [illegible] users, on the other hand, will record 5.9% sales growth, from $3.6 billion to $3.8 billion. The average price of such a system, however, should drop 4.3%, from $18,400 to $17,600. "One of the factors that is certain to emerge in 1987 is systems based on Intel's 80386," says Weathers. Part of the reason for this, says Weathers, "will be vastly increased memory and throughput, and decreased prices for workgroups. They [80386-based systems] will have prices significantly lower than minicomputers with the same functionality."

Sales of computers for technical applications should remain robust

Systems based on the 386 had already been announced in 1986 — most notably from clone leader COMPAQ Computer Corp. and original equipment manufacturer (OEM) supplier, Convergent Technologies Corp.

A 386 boost

Many participants are looking to the 386 to give the computer industry a much-needed morale boost in an otherwise tepid year. Convergent, in particular, is hoping its NGEN Series 386 will rejuvenate the company. After a year of both OEM and management defections, Paul Ely, Convergent's chairman, expects the 386 to have "a dramatic effect," on the company. "We have never introduced a product that has had broader or more universal acceptance," says Ely. Virtually all of Convergent's 200 customers, notes Ely, are supporting the NGEN Series 386.

This means a spate of 386-based product announcements in 1987, including an introduction by Convergent's largest OEM, Unisys. But the 386-based machine that the industry most anxiously awaits is Big Blue's. Many observers, including Ely, expect that IBM will also announce a proprietary operating system with its 386-based computer. But that doesn't worry Ely. Even IBM, says Ely, cannot afford to turn its back on the 50,000 application packages written for MS-DOS, the operating system developed by Microsoft that runs on IBM's PC XT and PC AT. What IBM will do, Ely anticipates, is offer its new system with an MS-DOS interface, similiar in purpose to Convergent's MS-DOS interface on its propietary operating system, CTOS. "That will be helpful to Convergent," says Ely. IBM's approach, he contends, "will legitimize all the alternatives provided by other vendors."

It is still anyone's guess when IBM will make its 386-based product announcement. Dataquest's Weathers believes that it will not happen until at least the fall of this year and perhaps as late as 1988. Ken Bosomworth, president of International Resource Development Inc. in Norwalk, Conn., thinks that IBM will show its hand sooner. In any event, says Bosomworth, if IBM does not reveal its cards by May, it may be too late for Japanese and Korean clone makers to duplicate compatible machines before the year-end. But one Korean clone maker, Goldstar, jumped into the foray feet first when it announced a 386-based machine last November.

Analysts are also expecting a lot of action at the other end of the computer spectrum. The supercomputer mar-

Business computers

U.S. market ($ billions)

System	1986	1987
Workgroup (2–10 users)	$3.60	$3.81
Small department (11–20 users)	3.06	3.30
Large department (21–64 users)	2.77	2.96
Business unit (65–149 users)	2.88	3.10
Corporate resource (150+ users)	6.75	6.85
Total	**$19.06**	**$20.02**

Source: Dataquest Inc.

ket, for example, shows no sign of a slowdown. Jeffry Canin, a senior analyst with Hambrecht & Quist Inc. in San Francisco, says shipment revenue will increase about 30% to $750 million in 1987. By 1990, Canin projects that supercomputers will be a $1.5 billion business.

Last year, 70 supercomputers were shipped. About half were Cray Research Inc.'s machines, seven were Cyber 205s, shipped by ETA Systems (formerly the supercomputer division of Control Data Corp.), and the remaining systems were sold by three Japanese manufacturers, Fujitsu, Hitachi and NEC. For 1987, Dataquest's Feeney points out that Cray's systems have already sold out, these systems having delivery lead times of up to a year.

While Cray will remain the dominant player, with 65% market share, Canin says that Fujitsu will eclipse ETA's second-place status inherited from CDC. But, despite inroads made elsewhere, Japanese manufacturers are still having trouble selling into the larger U.S. market. Part of their dilemma, says Canin, is that the U.S. government, which represents about 40% of Cray's business, is reluctant to buy from a non-American manufacturer. Another problem is that the Japanese makers underestimated the importance of application software and overestimated the desire for IBM-compatible machines in the supercomputer market.

A minisuper heat-up

The market for so-called minisupercomputers is also heating up. At the end of 1986, there were 450 minisuper systems installed worldwide and over one-third of these had been installed in that year, says Canin. But a few minisuper makers may have to avoid the heat by getting out of the kitchen. Already, says Canin, there is deep discounting going on in the three-year-old market. Cray, in contrast, has been shipping supercomputers for over a decade and has never had to discount a system to make a sale. The result, says Canin, will be a shakeout in the minisuper market leaving two or three start-ups out of about a dozen, left to compete.

And the competition will eventually be dominated by DEC and IBM. The discounting occurring now, says Canin, is due to competition from DEC. The Maynard, Mass., mini maker is offering steep discounts on its high-end VAX line, says Canin, to win contracts that the minisuper upstarts are targeting, too.

DEC is expected to make another response to the minisuper threat this year. Canin believes DEC will announce a high-end system with vector processing capability. Vector processing, found in Cray supercomputers and minisupers from Alliant Computer Systems Corp. and Convex Computer Systems Corp., enables a computer to work on matrices of number, rather than sequences of numbers. DEC's system, predicts Canin, will not be available for delivery until 1988.

IBM's answer to all of this, so far, has been to offer a vector processing add-on to its mainframe series. The add-on is competitive if a customer already owns an IBM mainframe. But if both, a vector processor, priced at $350,000, and a mainframe, priced upwards of $1 million, must be purchased, then IBM will have a tough time competing with minisupers, which average between $500,000 and $700,000.

Casey Powell, president of minisuper start-up Sequent Computer Corp. in Beaverton, Ore., sees a lot more going on in 1987 than a few product announcements. "We're going through some fundamental changes in the computer industry," says Powell. He believes that computer architectures are evolving from single processor configurations to multiple processor-based machines and they are either being utilized as multiprocessors (numerous processors running numerous, separate programs) or parallel processors (numerous processors running pieces of the same program in parallel time). As an example of this trend, Powell cites DEC's current high-end VAX 8800, which has two processors, and Data General Corp.'s top-of-the-line MV 20000, also a dual processor machine.

Whether Powell is right remains to be seen. But DEC, DG and IBM have more immediate concerns. DG, after a year of lackluster sales and a costly court settlement with Fairchild Semiconductor, "has to try desperately to bounce back," says IRD's Bosomworth.

Meanwhile, IBM is trying to cut costs through attrition and reduced spending in an effort to improve its pruned profits, which dropped 27% in the third quarter of 1986. At the same time, Big Blue has to be wary of the army of 386-based clones, while trying to counteract DEC's dominance in the mid-range market. IBM's 9370 minicomputer, announced last October and expected to ship by the end of 1987, is reportedly compatible with IBM's mainframes.

DEC, on the other hand, with a product line that was rejuvenated throughout 1986, will try to maintain its earnings momentum. But all manufacturers, including DEC — which does about 30% of its business outside the United States — will have to deal with an expected slowdown in European markets. Concludes IRD's Bosomworth: "DEC is on such a roll and the competition between DEC and IBM will be so fierce that DG may get left in the dust."

Most analysts agree that the potential threat of Unisys' won't be felt until at least 1988. "It will take awhile to consolidate their [Burroughs and Sperry] organizations and move both groups in the same direction," says Dataquest's Weathers.

Sequent's Powell predicts more deals in 1987. "I think its going to be another year of severe testing, consolidation and weeding out," says Powell. Weathers agrees. He expects continued mergers and acquisitions by companies "with substantial market share." But, Weathers warns, such megadeals are unpredictable. ☐

Peripherals: Heated action in an attached business

Manufacturers are having to adjust to slower growth and competition that just won't go away. More turbulence ahead

By John Kerr

In 1987, one element computer-peripherals makers will not lack is competition. They would prefer stronger demand and better profit margins. But with the inebriating growth rates of the computer revolution now history, they must settle for more sober increases in demand averaging 15% to 20% annually.

Confirms John Sasso, president of terminals maker Esprit Systems Inc. of Melville, N.Y.: "We're expecting to see continued improved growth, but nothing explosive. Now that most of us have got our inventories down, companies are healthier. The difficult times have made us all stronger."

Most maybe, but not all. Recovery is patchy: while some peripherals players are on a runner's high, plenty of others are wheezing behind. Ten disk-drive makers threw in the towel in the past year. Others exited the terminals sector. Several enhancement-board makers are hurting. That the pressure is still on is seen in faltering earnings by makers of everything from tape drives to printers.

For the most part, peripherals manufacturers begin 1987 a little wiser and considerably more careful. "Everybody got burned so badly in 1985 that there's a little Missouri [caution] in all of us," says Dan H. Wilkie, president of disk drive- and computer-maker Tandon Corp. of Chatsworth, Calif.

Wisdom, for drive makers like Maxtor Corp. of San Jose, Calif., means dedication only to the high-performance, high-capacity end of its markets where competition is cooler and margins remain respectable. For others like modem builder Novation Inc. of Chatsworth, Calif., it means escaping the fray by diving into niche markets such as fold-up boards for portable computers.

And for many, it translates into going where the action is — while it is still active. Producers of disk drives and modems alike have decided that personal computers (PCs) are where it's at. They are riding not so much on a tidal wave of demand for IBM's hot-shot PC AT desktop as on surging demand for clones the AT has spawned. Most of the rush is coming from add-on business, not from original-equipment manufacturer markets.

> For the most part, peripherals makers begin 1987 a little wiser and considerably more careful

Some question the wisdom of catching PC clone fever: "If I were competing in the 20- to 30-megabyte PC AT marketplace, I would wonder how much longer that market could continue to grow," says Skip Kilsdonk, Maxtor's marketing director.

The peripherals industry's new mood of realism is apparent in the terminals arena. "We've gone from a period of very high growth rates to a more mature phase," says Gregory W. Blatnik, associate director of the display terminals industry service of San Jose market research firm Dataquest Inc. Esprit's Sasso predicts 15% annual growth at best, much of it from add-on business.

Dataquest expects pricing slides to continue: for 1986 shipments by U.S. independent terminals manufacturers totaled 853,000 units worth $663 million. By the end of the decade, the units will be up — 1,425,000 — but the dollars down, at $566 million. So real dollar growth means growing market share.

Market leader Wyse Technology of San Jose plans to do that by offering more features — higher-resolution screens, more keyboard functions. Esprit aims to provide shinier after-sales service, and claims the strategy is working: gross margins are around 34% — a year ago they knelt nearer 27%.

In disk drives, the theme is that business is still no picnic. "The disk-drive industry is a very tough place to exist unless your product line is kept up to date, *and* you are a low-cost

Hard disk drive market

Worldwide revenue ($ millions)

	1985	1986	1987	1988	1989
Cartridges, packs	$938	$775	$654	$517	$411
Less than 30 MB	1,863	2,075	2,265	2,739	3,215
30 to 100 MB	1,279	1,909	2,098	2,157	2,128
100 to 300 MB	1,106	1,118	1,447	1,691	1,837
300 to 500 MB	1,332	1,293	1,795	2,112	2,285
More than 500 MB	7,199	7,880	10,454	13,931	15,772
Total revenue	**$13,717**	**$15,050**	**$18,713**	**$23,147**	**$25,648**

Source: Disk/Trend Inc.

producer, *and* you attain a major market share, *and* your management thinks clearly and works long days," says the latest report from market researcher Disk/Trend Inc. of Los Altos, Calif.

According to Disk/Trend vice president Robert Katzive, rigid-drive growth will continue, picking up from 1986's slump to spin at a compound annual average rate of 19.6% from 1987 to 1989. High-end 5.25-inch sectors will show up best as demand steps up from 30- to 100-megabyte units to 100 to 300 megabytes.

Does that mean any relief from intense pricing pressure? "I'd like to say 'no,' but I don't see it" says Chet Baffa, sales and marketing vice president at Micropolis Corp. in Chatsworth, Calif. Tandon's Wilkie adds that a unit price swing of $5 is reason enough for a customer to take a contract from one supplier and give it to another. "The survivor in this business is the low-cost producer," he says.

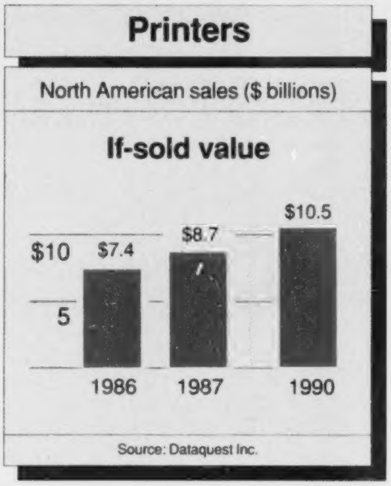
Among the lords of low cost are Seagate Technology in Scotts Valley, Calif., and turnaround Miniscribe Corp. of Longmont, Colo., which not long ago was in serious trouble. "If you're not a Seagate or a Miniscribe with those kinds of volumes, it's going to be tough," warns Katzive.

Tandon's high-volume hustle is in little 3.5-inch Winchester drives of 10- to 30-megabyte capacity, which it builds at up to 40,000 a month. They will help Tandon toward the 15% to 20% "up" year Wilkie anticipates in 1987.

Others expect good results too. Micropolis doubled in 1986 from a $95 million company in 1985, and expects strong sales throughout 1987 as demand from PC users pulls along its 50- to 85-megabyte drives.

Micropolis is one of those tilting toward the market's top end; this year its new 380-megabyte drive comes on stream. Maxtor's focus is higher still: marketing director Kilsdonk expects his new 760-megabyte 5.25-inch Winchester to be in pilot production by early February, and to form the basis of one of the first 1-gigabyte 5.25-inch units. He predicts that Maxtor's 1987 sales could be 30% better than 1986.

Emphasis away from mainframes and minis toward desktop computers has throttled back orders for tape-drive makers, according to Thomas Makmann, marketing vice president at Archive Corp. in Costa Mesa, Calif. Typically, demand is notching up at 15% to 20% annual rates compared to nearly double that in previous years.


Printers

North American sales ($ billions)

If-sold value

Source: Dataquest Inc.

This is disappointing some players: citing increased competition and squeezed margins, Cipher Data Products Inc. of San Diego is closing down a California plant as it moves more of its production to Singapore.

Market analysts also say 1987 should be the year that optical memory drives get noticed. Compact-disc types that can only be "read" will be most prominent, but write-once, read-many drives will begin to show up in practical applications.

Laser printers are steadily climbing the price-performance ramp

A state of siege

Printer business remains under siege throughout. Japan Inc. owns four-fifths of the U.S. market for low-end printers — that is, page printers capable of up to 10 pages a minute, and all serial printers. And the top end, where manufacturers like Printronix Inc. of Irvine, Calif., sell to mini and mainframe markets, is flat.

That has not stopped growth dead. Robert Fennell, senior industry analyst for Dataquest's printer industry service, reports that for the printer market overall, revenue will grow at 12% compounded through 1990, and at 14% in unit terms, indicating that price erosion is slackening. He forecasts price-performance improvements averaging 20% to 30% a year.

Fennell sees no easing of competitive pressures nor of profit margins during 1987. The market-share challenge will not be won by technology, he claims, but by those commanding the distribution channels.

A wide distribution net, he notes, is how Hewlett-Packard Co. of Palo Alto, Calif., spooned up the bulk of the market for what could be called "Product Pet of the Year": the low-cost laser printer.

Unveiled in 1984, Hewlett-Packard's laser printer opened up the floodgates for what is one of few bright spots for U.S. printer makers. According to Charles R. Cortright, product marketing director of the systems group at one aggressive competitor, AST Research Inc. of Irvine, Calif., the midrange laser printer business is expanding at over 40% annually.

Laser printers appeal to desktop computer users because they offer letter-quality output, quiet, speed and often graphics capability. They are steadily climbing the price-performance ramp: today's units handling six pages per minute and retailing for about $2,000 will soon crank out 20 pages per minute for little more cost.

The explosion in business use of big PCs also accounts for the 25% annual growth projected by another bullish breed: modem makers. Peter Field, marketing vice president at market leader Hayes Microcomputer Products Inc. of Norcross, Ga., adds a corollary: "The penetration of modems into those PCs is also growing," he says.

Contestants for second place, like Novation and Anchor Automation Inc. of Van Nuys, Calif., charge that Hayes prices as high as it likes because it enjoys terrific name recognition. The runners-up maintain that this policy will be forced to change as pricing pressure climbs.

Novation and Anchor hope to maintain strained gross margins by getting a jump on the shifts in demand from modems that transmit data at 300 baud, or bits per second, to 1,200-baud units and above. "There is a lot of upgrading to 2,400-baud going on," comments Jerry A. Henricks, Novation vice president of sales and marketing.

Like nearly every other peripherals sector, the modem arena remains bloody. "It's [a question of] who's going to get the business, and at what margins. But it's always more fun competing in a growing market than in a shrinking market," says Anchor chairman George Eisler. ☐

OUTLOOK '87

An uncertain future for U.S. chip makers

Market forecasts vary somewhat, but no one expects a turnaround soon in the volatile U.S. semiconductor market

By Beth Karlin

While there is no real consensus on the semiconductor industry's performance for 1987 and beyond, one thing is certain: The shakeout has begun, and from now on it's survival of the fittest. "There will be a lot of blood spilled, and of companies scrambling to the safety of niche markets," says Robert N. Noyce, vice chairman of Intel Corp. "But those that remain standing will be the stronger because of it."

Projections for growth vary. Worldwide consumption rose an estimated 23.4% to $30.64 billion (in constant U.S. dollars) in 1986 and will increase 17.7% to $36.08 billion in 1987 and 27.1% in 1988, according to Dataquest Inc., the San Jose, Calif., marketing company. Overcapacity, predicts Dataquest, will lead to a 1.3% decline in consumption for 1989. "The market environment for the industry as a whole is real tough," says Jon E. Cornell, head of semiconductor operations for Harris Corp., Melbourne, Fla. Cornell contends that his company is faring better than some of the others because of its concentration on government and noncommodity niche products.

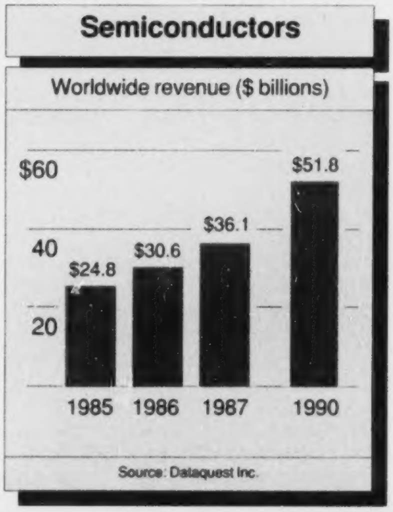
North America experienced the slowest growth. U.S. solid-state component shipments, for example, were expected to increase only 7% in 1986 to $8.65 billion, from $8.09 billion in 1985, according to the Semiconductor Industry Association (SIA). Distributor shipments increased 28.6% for the year, while original equipment manufacturer shipments increased only 1.2%. In 1987, the SIA projects that U.S. shipments will grow 21.7% to $10.5 billion. European shipments, meanwhile, increased 17.8% in 1986, and Japanese shipments jumped almost 40%, according to the SIA.

Clouding the picture, however, is the impact of fluctuating exchange rates. When 1984 exchange rates are used, for example, actual growth in Japan dropped from 40% to 1.2% for 1986 and European growth drops to 0.7% for the year. Averaged together, real growth in the U.S. and other international markets was 7% in 1986, according to SIA. "We hoped 1986 would be a recovery from the worst year in the semiconductor business," says Cornell. "But 7% real growth is hardly a recovery."

Ailing Japan

Japan is suffering as much as — or perhaps even more than — the U.S. semiconductor companies. In addition to sluggish worldwide demand, both the strength of the yen to the dollar and the floor prices dictated by the U.S.-Japan trade accord are cutting into profits. Until recently, Japan's share of the world market was slightly less than 40% and U.S. merchant semiconductor companies had almost 50%. But Japan has since increased its presence, while the U.S. merchants' share has fallen somewhat.

For the next five or six years, says Robert E. McGeary, director of semiconductor equipment and materials service for Dataquest, "market shares [measured in U.S. dollars] will flip-flop back and forth." In unit sales, Japanese and U.S. merchant companies will stay within 5% of each other, with the United States still ahead.


Semiconductors

Source: Dataquest Inc.

Increasingly, Japanese companies are building U.S. fabrication facilities. Hitachi America Ltd. has established a new plant in Texas, and Sharp Electronics Corp., Mitsubishi and NEC Corp. are planning to expand in the United States. By manufacturing locally, Japanese suppliers can get around antidumping regulations, reduce the impact of currency fluctuations, and meet growing demand for popular application-specific integrated circuits.

Korea, meanwhile, is expanding its domestic semiconductor capacity with hopes of becoming a major international player. "Korea is spending prodigious amounts of money on very modern equipment," says McGeary.

Cutbacks

Faced with an uncertain future, companies are cutting back. In October, for example, Harris laid off 500 semiconductor workers, 10% of its international workforce. The same month, Advanced Micro Devices Inc. (AMD), Sunnyvale, Calif., rescinded its formal no-layoff policy and reduced its 12,800-employee worldwide workforce by 500. "No significant indications of improvement in demand have emerged, and our expectations near term are for only modest industry growth," says W.J. Sanders III, AMD chairman.

Semiconductor makers are hoping prices will stabilize after more than a year of price wars for many products. In April 1986, for example, the average selling price of complementary metal-oxide semiconductor (CMOS) memories was 28% lower than a year earlier, according to the Integrated Circuit Engineering Corp., Scottsdale, Ariz. "Pricing for most products has recovered pretty well," says an AMD spokesman.

In some cases, memory buyers complained that prices were too high — as a result of the U.S.-Japan trade accord on dynamic-random access memories (RAMs) and erasable programmable read-only memories (EPROMs) in August. After that agreement, Japanese manufacturers and U.S. semiconductor companies that make products in Japan scurried to re-adjust their prices to the dictated fair market value (FMV) floor prices. Computer makers in particular claimed that the DRAM prices were artificially inflated.

> "It would be ludicrous for anyone to suggest that we can go back to the way things were during the infancy of our industry"
>
> Robert Noyce of Intel

A new round of FMV came out in October, and the U.S. Trade Representative's Office argued that pricing would stabilize at a competitive level. Besides, says U.S. Trade Representative Clayton Yeutter. "There is no consumer of semiconductors or any other product who is entitled to insist on dumped prices." Yeutter also reacted to critics who called the FMVs a price umbrella. "The talk of a price cartel . . . is just sheer, unadulterated nonsense," he says. "Not one word of this agreement established price."

Although semiconductor makers are optimistic that the chip business will once again become a healthy business, they do not expect it to be as robust as it was in the early years. "It would be ludicrous for anyone to suggest that we can go back to the way things were during the infancy of our industry," says Noyce. "Things changed quickly then, and new technology was enough to assure a profit. Those days are over."

Noyce believes, however, that the problems facing the industry can be solved. By 1991, he predicts, the domestic semiconductor industry will once again be strong. "Now that the battle flag has been raised," says Noyce, "I think we'll finally start to see some results." ☐

EXECUTIVE RECRUITMENT

1987 Executive Recruitment Editorial Calendar

Issue Date	*deadline*	*Special Features*	*Management Strategies/Analysis*	*Bonus Distribution at Trade Shows*
February 1	Jan. 12	Top Superminicomputer Companies	Materials Handling	
February 15	Jan. 23	CIM	Electronics Factory of Future	Nepcon West 2/24-26
March 1	Feb. 9	Top Semiconductor Companies	CEPS	Ceps V 3/3-5 Semicon Europa 3/10-12
March 15	Feb. 23	Top Engineering Workstation Cos.	University Parks	NCGA 3/22-26 Southcon 3/24-26 ADEE 3/31-4/2
April 1	March 9	Best Executives	Power Supplies	Electro 4/7-9
April 15	March 23	Fastest Growing Companies	Military Electronics	
May 1	April 9	Computers	CMOS ICS	Canadian Hi-Tech 5/5-6 EDS 5/13-15
May 15	April 23	Semiconductor Production	Top Venture Capital Firms	Semicon West 5/18-21
June 1	May 11	Top Computer Companies	Distribution	Nepcon East 6/9-11
June 15	May 25	Top CAE Companies	ATE	ATE East 6/23-25 NCC 6/15-18
July 1	June 9	1987 Midyear Forecast Update	Artificial Intelligence	
July 15	June 23	*Electronic Business 200*	Military Electronics	Siggraph 7/27-31
August 1	July 9	Top Capital Equipment Spenders	Selling to the Government	

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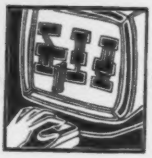


CAE/CAD/CAM: Continued sluggishness in the industry

Efforts by customers to freeze capital spending on CAD/CAM gear and continuing price erosion could slow domestic sales

By Alden M. Hayashi

Unless frozen customer budgets begin thawing, 1987 will be another disappointing year for the CAE/CAD/CAM industry. Product price erosion will continue to eat into market revenue, some analysts also suggest, as sales in foreign markets may level off.

After growing by 56% in 1984, the CAE/CAD/CAM (computer-aided engineering/design/manufacturing) industry continued losing speed last year. Reaching sales of $4.09 billion, the industry could grow by only 14.1%, according to Daratech Inc., a market research firm located in Cambridge, Mass. Daratech says this year could be even worse. "I'm not very bullish on 1987," says Charles M. Foundyller, Daratech president. Foundyller is predicting a growth of just 11%.

Many of the CAE/CAD/CAM vendors claim 11% is too pessimistic. However, no one is betting on a recovery anytime soon. "We expect to see growth in the market but we expect it to be moderate," says Robert Moore, marketing director for Daisy Systems Corp. of Mountain View, Calif. Adds Thomas H. Bruggere, president of Mentor Graphics Corp. of Beaverton, Ore.: "We feel pretty good about next year but we're not assuming any big turnaround."

Uncertainty concerning customer budgets has capped the industry's optimism. Reportedly, customers have budgeted, but not yet spent, hundreds of millions of dollars for CAE/CAD/CAM equipment. For electronics CAE alone, The Technology Research Group Inc. of Boston estimates that U.S. customers last summer had a combined budgetary surplus of more than $500 million.

Whether or not this money will be spent this year is highly questionable. CAE/CAD/CAM systems are costly purchases, and customers lately have been reluctant to part with their money. The slump in the general electronics industry, historically a major customer of CAE/CAD/CAM equipment, has not helped. Currently the CAE/CAD/CAM industry, particularly in the electronics segment, suffers from a syndrome of too pricey products chasing too poor customers.

Pressure to automate

Regardless, the pressure for customers to automate and buy CAE/CAD/CAM equipment soon may become unbearable, says Robert A. Fischer, in charge of the CAD/CAM and workstations group for Prime Computer Inc. of Natick, Mass. "To maintain their competitiveness, customers will have no choice but to take advantage of the tools available. You can cut back on your capital expenditure program for only so long," says Fischer.

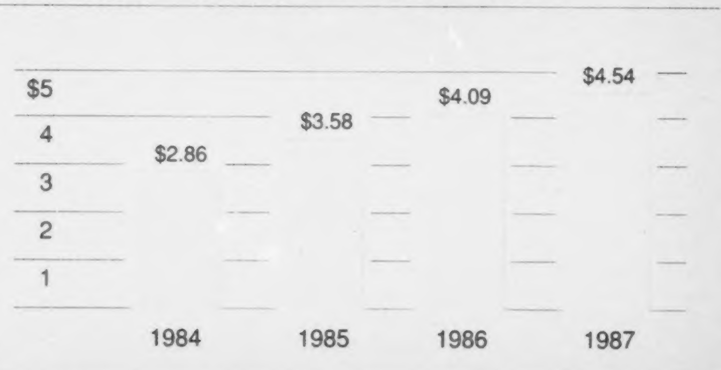
Still, customers thus far have managed to refrain from making major purchases. Many vendors had expected that customers would be freeing up budgeted moneys by now [ELECTRONIC BUSINESS July 1, p90]. "It's certainly a lot more sluggish now than I thought it would be a year ago. Many customers have taken a let's-wait-and-see attitude," says John W. Gridley Jr., chief financial officer of Intergraph Corp. of Huntsville, Ala.

And the recent U.S. tax law changes have not really helped the CAE/CAD/CAM industry, adds Gridley. He explains that while the tax law revisions will help spur consumers to buy goods such as automobiles and televisions, they will do little to encourage companies to increase their capital expenditures. "There doesn't seem to be anything there to stimulate any demand for our products," says Gridley.

Unfortunately, a stimulation of demand is just what the market needs right now. Without it, vendors remain unsure as to exactly when customer budgets will begin to free up. "There's more uncertainty now than before and the bottom line is: we really don't know when things will get better," says Gridley. Adds David R. Foster, vice president of marketing for Valid

CAE/CAD/CAM

Worldwide sales ($ billions)



Source: Daratech Inc.

Logic Systems Inc. of San Jose, Calif.: "I really don't know, with the uncertainty in this marketplace, how we can make any educated projections."

But vendors maintain, and market analysts concur, that the frozen budgets do not indicate customer discontent with the CAE/CAD/CAM technology. "On the contrary, the vote of confidence of using CAD/CAM is probably at an all time high," says Daratech's Foundyller.

Some in the industry wonder whether customer budgetary surpluses still exist. "I think the money isn't there anymore. I think companies budget contingent upon their own performance," says Foundyller. He explains that although companies that are doing poorly may not officially readjust and cut their budgets, they will invent other ways to curb spending, for example, by adding more red tape to the purchasing process. "They'll essentially kill the money," says Foundyller. Adds Bardwell Salmon, a vice president of Computervision Corp. of Bedford, Mass.: "The real message is: The money is not going unspent," because it is not there anymore.

CAE/CAD/CAM

1986 worldwide market share

IBM	23.9%
Intergraph	14.8%
Computervision	11.8%
Calma	5.0%
McDonnell Douglas	4.5%
Applicon	4.2%
Mentor	4.2%
Prime	3.4%
Control Data	2.9%
Daisy	2.3%

Total 1986 market
$4.09 billion

Source: Daratech Inc.

Frugal customers

A price erosion in the industry also has slowed industry sales. According to Laura Conigliaro, analyst for Prudential-Bache Securities Inc. of New York City, the price per seat of a CAE/CAD/CAM system has fallen sharply, from upward of $125,000 two years ago to roughly $40,000 currently.

This tremendous price decline mainly has been due to the increasing popularity of the personal computer (PC). Daisy's Moore reports that PC-based products now account for 50% of his company's sales on a dollar basis and 70% on a unit basis. Several years ago, Daisy's systems were based exclusively on more expensive super microcomputer workstations. "There's been tremendous growth in the low end of the market," agrees Intergraph's Gridley. In fact, Computervision's Salmon says that certain PC-based CAD products, such as those automating two-dimensional drafting, rapidly are becoming commodity products. "There are packages out there selling for less than $1,000," he says.

Daratech's Foundyller predicts that the price erosion will continue throughout 1987. He says that while the dollar growth of the industry will be around 15% this year, the unit growth will be closer to 25%. Particularly in these touchy economic times, "people will be reluctant to go for the top-of-the-line systems," says Foundyller. "The price of the units themselves, they're not going to be radically different. But a price erosion will continue to occur in terms of the product mix that customers will buy. Before, a customer might have bought two of System X [a cheap system] and four of System Y [a more expensive system]. Now, they're going to buy four of System X and two of Y."

> Certain PC-based CAD products, such as those automating two-dimensional drafting, rapidly are becoming commodity products

Success overseas?

Yet, while domestic sales have slowed, virtually all of the CAE/CAD/CAM vendors report flourishing business overseas. Daisy's Moore says that international sales accounted for about one-half of his company's total sales last year, up from one-third in 1985.

"We see, in particular, the European market as being strong," says Computervision's Salmon. Indeed, says Kenneth B. Fine, Valid president. Valid's sales in Europe alone have grown from 25% of total sales to about 50% last year, according to Fine. "There's a lot of pent-up demand there," claims Daisy's Moore. He explains that the European CAE market is at least one year behind the U.S. market. Consequently, the fast-growing early-adopter market in Europe has not been saturated yet, as has been the case in the United States.

Europe is not the only foreign market vendors are counting on. Mentor reports that its sales in Japan increased by 50% last year. "The Japanese companies are still hurting but they're still spending," claims Mentor's Bruggere. He estimates that the Japanese market lags the U.S. by two years.

Last year's success in overseas markets will be difficult to maintain this year. Daratech's Foundyller explains that the recent depreciation of the dollar's value was the chief reason behind the success last year of U.S. companies in foreign markets. The dollar's depreciation enabled many companies to report huge increases of foreign sales on a dollar basis when, in fact, those same sales on a foreign currency basis were flat. Foundyller warns that U.S. companies will not have that advantage this year, assuming the dollar doesn't drop further. ☐

Production equipment: Up slightly but still tough going

It will be survival of the fittest for makers of semiconductor production gear in 1987. But brighter days lie ahead in 1988

By Mark Mehler

Semiconductor producers, for the second year in a row, will be able to supply more components than their customers will demand. So it is not surprising that the folks who supply equipment to those producers are braced for another lackluster year.

Worldwide sales of semiconductor production equipment will rise 8% to $5.35 billion in 1987, but expand 33% to $7.2 billion in 1988, predicts VLSI Research Inc. The market research firm figures that equipment makers closed their 1986 books with $4.97 billion in sales, down 20% from the previous year.

"This is clearly the worst sustained recession in the industry's history," says G. Daniel Hutcheson, president of San Jose, California-based VLSI. "Right now, the problem equipment suppliers are having is the booking levels have been so low for so long, with no hard upswing in the near future, that they're having to make major cutbacks in their organizations."

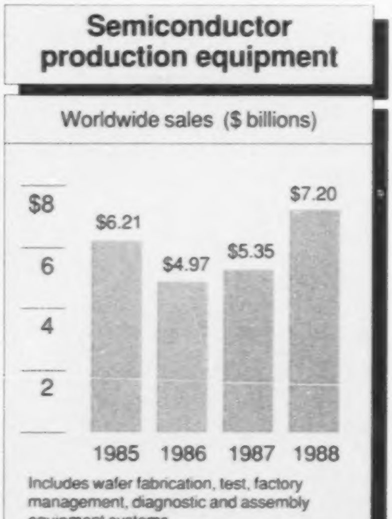
An even more pessimistic view surfaces in a market study by one equipment supplier. The report estimates excess capacity for 1- to 3-micron integrated circuits, representing the bulk of current IC output, reached 20% in the second half of last year. Although the study points to the promise of submicron geometries driving future purchases of advanced equipment, the report predicts the equipment industry will continue to shrink.

No one spared

Despite VLSI Research's rosy prognosis for 1988, even the largest and most heavily capitalized equipment manufacturers have been unable to avoid major surgery.

Eaton Corp., the $3.7 billion conglomerate, last fall discontinued production of its wafer steppers, in-process testers and automatic test equipment. Cleveland-based Eaton, ranked No. 6 in integrated circuit equipment sales just two years ago, cited the need to increase cash flow and concentrate on its mainstream truck parts and defense businesses. Eaton, which sold $185 million worth of IC equipment of all types in 1985, will continue supplying ion beam systems for the IC industry.

Perkin-Elmer Corp., the Norwalk, Connecticut-based market leader, saw semiconductor equipment sales fall about 21% from $330 million to $260 million in the fiscal year that ended last July 31. "This is a time to batten down the hatches," says Charles Minihan, who heads PE's Semiconductor Equipment Group. "For us, that means controlling expenses and allocating R&D [research and development] dollars on a prioritized basis. Lithography [optical and electron-beam exposure systems] is our principal business activity, and that is the area that we will focus on in this climate." Sources indicate that PE plans an exit from its plasma etch and sputter deposition businesses, although Minihan says the company is continuing to seek orders for such machines.


Semiconductor production equipment

Worldwide sales ($ billions)

Includes wafer fabrication, test, factory management, diagnostic and assembly equipment systems

Source: VLSI Research Inc.

General Signal Corp., the No. 3 supplier with $218 million in 1985 sales of IC equipment, is also pulling in its horns. Company officials last fall acknowledged that its Micro Automation unit, a maker of wafer-dicing saws, is for sale.

Veeco Instruments Inc. is another supplier reportedly questioning the wisdom of offering a broad line of IC equipment. "We need to adjust our levels of expenses and inventories to be [in sync] with the soft market," says B. Alan Ross, general manager of Veeco's Equipment Division, explaining why the Long Island, N.Y., company last fall took a write-down of excess inventory of ion implanters. Since 1984, Veeco has only sold about 10 of the $1.2 million systems, which shoot ions into wafers to give them the desired polarities.

The smaller independent merchant equipment vendors also are scrambling to maintain sufficient volume to ride out 1987 intact. Machine Technology Inc., a maker of photoresist processing systems and other front-end fabrication equipment, elected late last summer to take on another $1 million in long-term debt. Gary Hillman, president of Parsippany, New Jersey-based MTI, believes it will take even more than additional leveraging to survive the recession.

"People talk a lot about the need to reduce manufacturing costs, but ultimately you have to be able to develop products more cheaply, to learn to be a low-cost innovator as well," he argues. Whereas the typical cost of developing a new IC system is roughly

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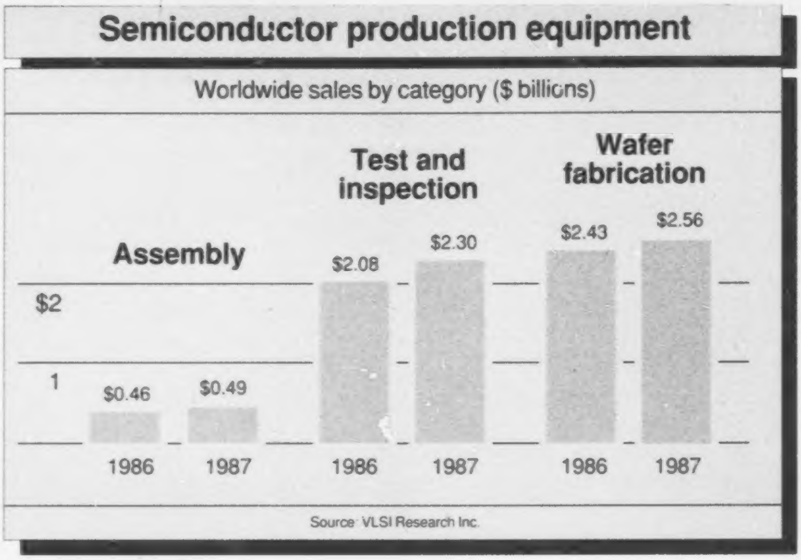


Semiconductor production equipment

Source: VLSI Research Inc.

10 times the product's selling price, MTI spent only $3.5 million to bring its $1 million sputtering system to market last year, Hillman says.

"Our way of squeezing out the cost of R&D is very messy; a Harvard MBA certainly wouldn't appreciate it," Hillman concludes. "But if you start with the basic premise that our business is the creation of intellectual value, then that's where you husband your resources."

For others, the key survival tool is diversification into related markets. Consilium Inc., a supplier of software modules for computer-integrated manufacturing (CIM) of semiconductors, over the past six months has begun pushing into such new markets as aerospace, chemicals, automotive and genetic engineering. New customers include Boeing Co., Commodore Business Machines Inc. and Westinghouse Electric Corp. "In 1986, about 40% of our [approximately $12 million] business was outside semiconductors," says Consilium's president, Jonathan Golovin. "In 1987 it will be about 50% . . . our [IC] customers are shell-shocked. We have to think about expanding our user base."

Those vendors continuing to express confidence in the silicon-based IC market tend to be suppliers of either automation- or yield-related products. For example, Semi-Gas Systems Inc., a maker of equipment to purge impure gases from the process line, looks for a fairly strong 10% to 15% hike in volume this year. "We're encouraged that our customers are getting strong legislative pressure to clean up their processes," says Andrew Lorenz, president of San Jose, California-based Semi-Gas.

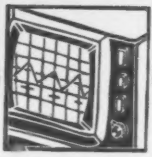
SMT-driven growth

A slightly brighter picture emerges in the printed circuit board (PCB) production equipment market. Universal Instruments Corp., the leader in the $300 million market segment for component insertion and placement equipment, is more optimistic about the coming year.

The cause of Universal's optimism is surface mount technology. SMT, which involves mounting devices on a printed circuit board rather than inserting them through holes, is rapidly driving the equipment business in the direction of flexible (high-mix, low-volume) manufacturing.

"That's what we're gearing up to do — automated, versatile-type production lines," says James Roth, vice president of sales and marketing for Universal. "Our Japanese competitors are not tooled up to handle versatile loads."

The growth of surface mounting will be the No. 1 trend in 1987, agrees Charles Giordanella, vice president of marketing for International Robomation/Intelligence, a Carlsbad, Calif., supplier of vision systems for PCBs. Indeed, he notes, the added emphasis on packaging, as the means of providing more power on a board, is bringing the PCB and semiconductor industries closer together. In this vein, IRI recently introduced a new system to inspect the wire bond of an assembled chip. ☐



Test and measurement: Don't look for any miracles

Instruments and ATE will grow steadily, but there won't be a big turnaround without help from other industries

By David Card

Suppliers of test and measurement (T&M) gear must be asking themselves, "How many more times are we going to hear the line about a second-half recovery?" One more time, anyway.

Last year, the industry grew only 0.3% in sales worldwide, according to Galen Wampler, president of market researcher Prime Data Inc. in San Jose, Calif. But Wampler says fluctuations in currency values exaggerated even that miniscule growth, and that unit sales were actually down. This year, research and development spending will fuel dollar sales to over $7 billion, for a growth rate over 10%, Wampler forecasts.

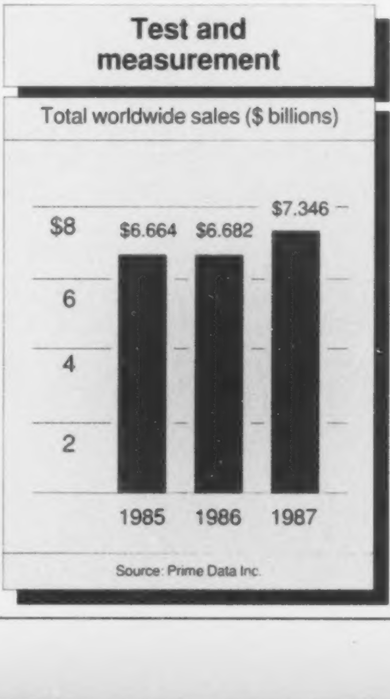
If the general economy is peppy enough, even automatic test equipment (ATE) — which is more dependent on capital spending related to production than to research and development (R&D) — could rebound in the second half of the year, finishing with 8.5% growth, adds Kenneth Neff, who tracks ATE for Prime Data. That would be up dramatically from its 14% drop in 1986, he points out.

Two major customers of test and measurement equipment — computer manufacturers and military/aerospace companies — have curbed their purchases and show no signs of rapidly turning around, Wampler says. Computer makers, which account for some 16% to 18% of test and measurement sales, still seem caught in a slump.

The military/aerospace segment, worth 27% of the market, shows little reason for hope. Wampler sees hardly any sign of strong growth in T&M sales to the U.S. armed forces. And of the aerospace companies Wampler says: "People have been watching their pennies — I should say dollars." Mergers and acquisitions in that industry — and accusations of overcharging — are causing companies to scrutinize their expenses. A Democrat as president in 1988 could darken the defense market considerably, he says.

Along with computer manufacturers, merchant semiconductor companies are a favorite scapegoat for T&M's 1985-1986 woes. "When your factories are running at 60% capacity, you can just about double your sales without adding any capital equipment," says Joseph Keithley, chairman of Keithley Instruments Inc., in reference to the chip companies. Likewise, computer sales would have to rise 20% to 25% to pump up instrument sales, adds Thomas Brick, president of the Cleveland-based Keithley.

> "We certainly see no signs of a massive turnaround"
> Michael Gasparian of Hewlett-Packard



Test and measurement

Total worldwide sales ($ billions)

Source: Prime Data Inc.

"We certainly see no signs of a massive turnaround," says Michael Gasparian, product marketing manager for the Colorado Springs Division of instruments king Hewlett-Packard Co.

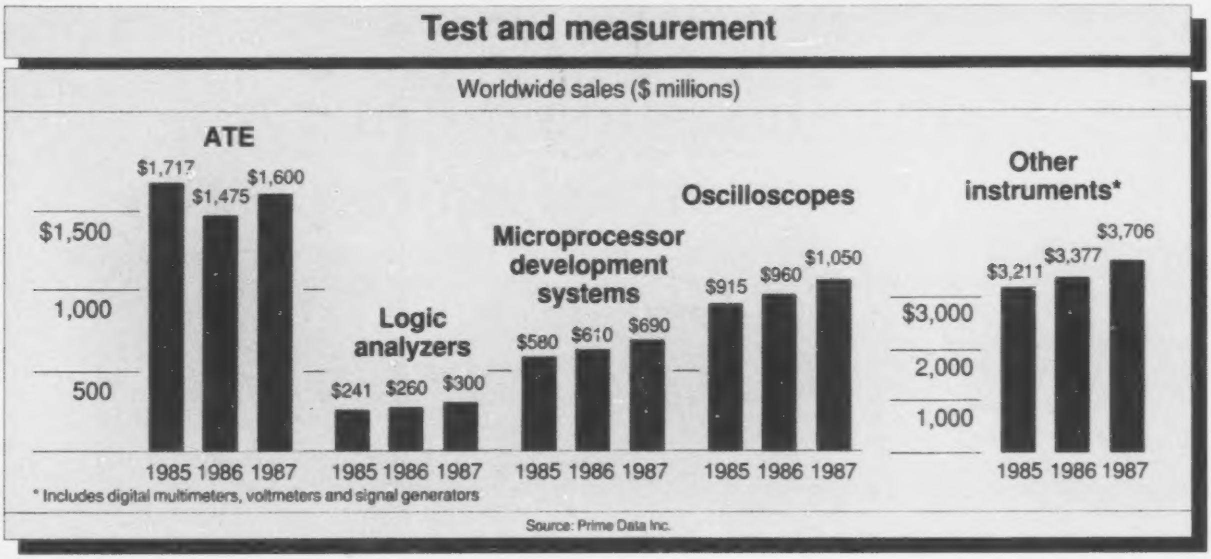
Taxing questions

Industry observers give mixed reviews to the U.S. tax reform bill signed into law by President Reagan last October. Most agree that at least the wondering is over. "The uncertainties are gone, but what replaces them is not positive enough to force purchases for tax reasons," says Prime Data's Wampler. "There is no advantage to buying something sooner, but putting it off is no worse," Wampler concludes. Frederick Bihler, president of the U.S. subsidiary of Japanese ATE and instruments company Advantest Corp., agrees: "It's not good, but at least we know what it is."

Hewlett-Packard's Gasparian is not so sure. He thinks the new tax law has left the electronics industry in a quandary. He reasons that what he describes as an 800-page bill will require some time to decipher. Until companies figure it out, there will be no big instrument purchases.

In oscilloscopes, market leader Tektronix Inc. of Beaverton, Ore., recently introduced its first new line of scopes in 17 years. And wonder of wonders, the line is anchored by a group of modular-design analog scopes. "There is a tremendous amount of activity left in analog," contends Fred Hanson, who heads Tek's Instruments Group. "Contrary to what some might say, there is a lot of life yet."

Those "some" include Hewlett-Packard, which exited the analog scope market about two years ago to concentrate solely on digital. HP's Gasparian claims HP's scopes are selling faster than the market is growing. (Digital scope sales grew 20% last year


Test and measurement

Worldwide sales ($ millions)

* Includes digital multimeters, voltmeters and signal generators

Source: Prime Data Inc.

while analog sales were flat, according to Prime Data. Digital scopes also are generally higher priced than their analog counterparts.)

Nontraditional customers, notably auto makers, have partly fueled HP's fast pace in digital scopes. Gasparian says, of course, that digital scopes offer performance benefits that the newer users are just figuring out. Still, Tek claims — and Wampler confirms — that Tek has the dominant position in digital as well as analog scopes.

Makers of spectrum analyzers, meanwhile, are benefiting from two influences — continued R&D spending by all of their customers and strong capital spending by one of their major customer segments, communications equipment producers. They are also beset by heightened inernational competition.

Marconi Instruments Ltd. of Hertfordshire, England, is seeking to penetrate further the U.S. market from its strong European base, even though it too is under attack. Japanese spectrum analyzers are pouring into European markets, observes Marconi's instruments chief, Sandy Warwick. "Certainly in our business we're more worried about the Japanese than HP is worried about us," Warwick says. "But we're all looking over our shoulders at Japan."

Logic analyzers, used in the design of digital systems, also will continue to benefit from the R&D push, Wampler says. Even though it is the fastest growing of the major instruments segments, competitors are trying to inspire sales. HP has taken to sales gimmicks — the company gives away an ink-jet printer with some sales, and it will soon offer free disk drives.

Tek is positioning its logic analyzer as a front end to a test line-up for application-specific integrated circuits (ASICs), according to Design Automation Group head Tom Long. Tek is jumping on the ASIC bandwagon with its logic analyzer, its new Delta series of instrument modules and its new ATE system. "We don't give a damn which way it goes," Long says, just so ASIC vendors buy some component of Tek's line to exercise their chips.

ASICs, says analyst Neff, have spawned a whole new industry: verification testing. Led by Integrated Measurement Systems Inc. of Beaverton, a flock of start-ups has developed systems poised somewhere between standalone instruments and ATE, to test the prototypes and short production runs of custom chips. Cadic, also of Beaverton, is one such company betting that the start-ups can nimbly stay ahead of Tek and HP, like "thoroughbreds versus dinosaurs," in the words of Cadic president Clifford Yee.

> "There is a tremendous amount of activity left in analog"
>
> Fred Hanson of Tektronix

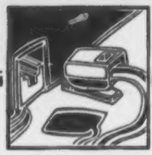
"Assuming the economy will turn around at midyear," Prime Data's Neff says, "ATE sales will still be below the level they were in 1985." Board test has been hurting longer than chip test, Neff says, but he holds little hope for any pent-up demand to push sales in 1987.

"I wouldn't get too carried away yet," says Craig Pynne, marketing vice president of board tester Zehntel Inc. of Walnut Creek, Calif. He pretty much speaks for the industry when he says he is "gearing the business to sell what we shipped in '86."

In the desperate ATE market, companies have been slashing prices. Pynne says he had to set up a system where his salesmen get a bonus for making a sale at list price. Schlumberger Ltd.'s chip test unit, Sentry, has seen prices drop on its older line of testers — the installed base of which is the industry's largest — to a profit margin-threatening point.

The margins of Sentry's older line benefit from mature technologies, while the new line uses more expensive new technologies but fewer parts. Sentry vice president Fred Laccabue claims his company is nearing the point where the cost of manufacturing both lines is equal. There is one hitch, however. Even though the new line is becoming cheaper to build, it has not caught on in the United States.

Practically the only testers selling in late 1986 were the ultra high-end systems for very large-scale integration (VLSI) chips, Neff says. "People are buying the big testers for their next generation products," he explains. One hotbed of competition, if not volume, was at Intel Corp. Long a Teradyne Inc. customer, Intel has gone with LTX Corp. subsidiary Trillium for the first stage of a potentially huge ATE contract. ☐



Communications: Emerging markets promise more profits

Equipment vendors should dial T-1 multiplexers and fiber optics. PBX and key systems are busy

By Carol Suby

In the never-ending saga of what's hot and what's not in the communications equipment industry, technological advances, regulatory changes and evolving standards are stimulating growth in some equipment segments while ushering in the demise of others.

Overall, the U.S. telecommunications industry — including services and equipment — is expected to grow from $159.4 billion at the end of 1986 to $176.9 billion by the end of 1987, according to market research firm Dataquest Inc. in San Jose, Calif. The equipment portion represents about 14% of the total industry, and growth in this segment is expected to increase from 1986's $22.3 billion to an estimated $24.8 billion during the 1987 calendar year. Areas such as fiber optics and T-1 multiplexers are promising robust growth this year. In addition, integrated circuits (ICs) used in communications equipment continue to provide a ray of sunshine for an otherwise beleaguered semiconductor industry.

Other segments are not expected to fare as well, especially in the area of key telephone systems. This market, which includes feature-rich phones that contain buttons or keys used to select a specific line from several incoming lines, will continue to be fraught with increased competition, pricing pressures and declining profit margins.

Big switch competition

The boom times for central office (CO) switches, the giant machines used by telephone companies to route calls, appear to be over. Nevertheless, a CO-switch market share race is gearing up in the United States, which until now has only included AT&T and Northern Telecom Ltd. The pair shipped 88% of the 12 million analog and digital CO lines sold in 1986, according to Northern Business Information Inc. (NBI), a market research firm in New York City.

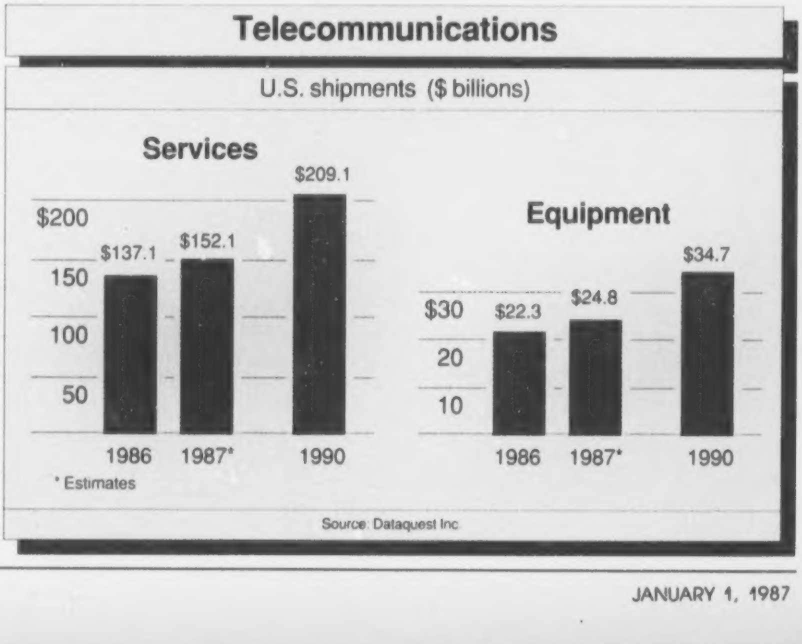
The largest customer base for CO switches — the seven regional Bell holding companies (RHCs) — accounted for the purchase of an estimated 85% of the approximately 11 million digital CO lines shipped last year, NBI estimates. These deep-pocketed customers are looking to add at least one other vendor to their lists of CO suppliers. This year many analysts expect to see a clear third vendor emerge. The two strongest contenders appear to be Siemens Communications Systems Inc., the Boca Raton, Florida-based subsidiary of Siemens AG, Munich, West Germany; and Ericsson Inc., the Richardson, Texas-based subsidiary of Sweden's L.M. Ericsson Telephone Co.

"If money can buy happiness, maybe it can also buy market share. And Siemens has tons of it," says Glenn Powers, senior analyst at NBI. He estimates that Siemens has spent hundreds of millions of dollars for both marketing and product development of CO and customer premises equipment (CPE). And, although globally Siemens "has a ton of lines on order," not many of them have been delivered, Powers says. Indeed, according to NBI's latest figures, Siemens only had a 1% share of the 21 million digital local lines (CO lines excluding trunks or toll switches) shipped worldwide in 1985.

Although Ericsson has gained less notoriety in the United States than its German rival, the firm has landed several agreements with many of the RHCs. Moreover, Ericsson has a leg up on Siemens in the worldwide market with a 10% share of the 1985 shipments of digital local lines, NBI says.

Switchboard struggles

The five leaders in the U.S. market for private branch exchanges (PBXs) — AT&T, Northern Telecom, Mitel Corp., NEC Corp. and IBM's ROLM

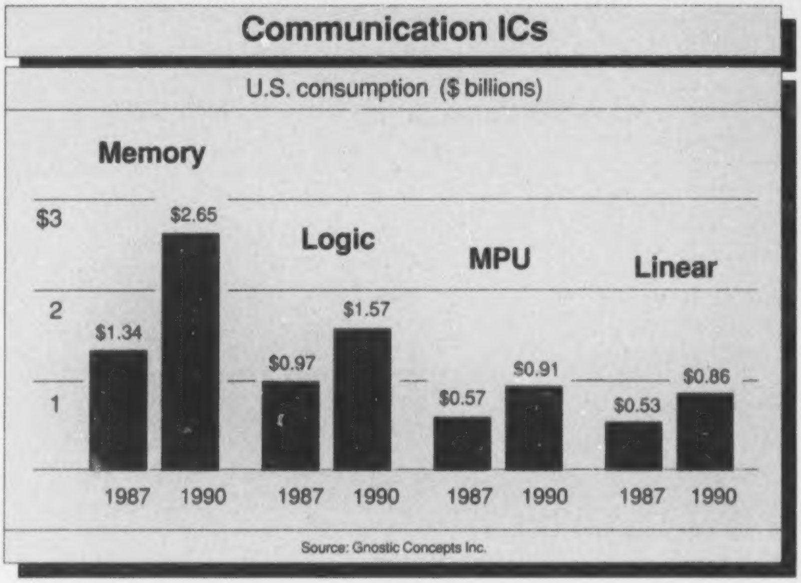


* Estimates

Source: Dataquest Inc.

Communication ICs

U.S. consumption ($ billions)



Source: Gnostic Concepts Inc.

Corp. — are expected to rack up a collective $500-million loss on their U.S. PBX sales this year. Nevertheless, 1987 is forecasted to be better for switchboard makers than the past several years, says Gregory Carlsted, an analyst at Dataquest Inc. The San Jose market research firm estimates that annual domestic PBX sales, which have hovered around $3.1 billion for the past few years, will rise 10% this year.

Fueling PBX demand, Carlsted says, will be an increase in volume sales as well as a rise in prices on middle-level and high-end products. The price hikes are driven by increased complexities such as the adding of office-automation functions and datacommunications features.

Sunny skies continue to elude the majority of vendors that sell key telephone systems (KTS). "It is extremely difficult to be profitable in this commodity market," Carlsted says. He reasons that the lack of growth in the KTS arena, with U.S. annual sales expected to remain flat the rest of the decade, will force company consolidations in this $2.1 billion telecommunications segment.

Bright lights

The segment that promises the most growth through 1990 is transmission equipment — a $5-billion U.S. market, pegged to grow to $5.5 billion by the end of this year and reach $7.3 billion by the end of 1990, according to NBI analyst Michael Miller. Representing $3.16 billion or more than half of the transmission equipment market, carrier equipment is expected to grow to $3.573 billion by the end of this year and hit $4.672 billion by the end of this decade. Included in carrier equipment, and the brightest performer in this segment, is fiber optics.

Although installation of fiber-optic cable and components is slowing in long-distance carrier applications, it is expanding at the opposite end of the network. Fiber optics at the distribution and subscriber loops (the parts of the network interconnecting central offices and reaching the end users) may, in fact, come to represent more than 90% of all network fiber installations, says Jon Zilber, director of West Coast operations for Kessler Marketing Intelligence, a market research firm.

In addition, the cost of fiber-optic components — the most price-intensive part of the market — is coming down. For example, the laser portion of a fiber-optic transmitter sells for an average price of $2,000, but one vendor recently announced a laser in the $500 to $600 price range. The industry expects to see $100 lasers in the not too distant future.

The total value of the domestic fiber-optics market is expected to grow from $875 million to $1.026 billion this year, reaching $1.838 billion by 1990, according to NBI's Miller. The major portion of this segment, fiber-optic electronics — which includes components such as lasers and light-emitting diodes — is expected to grow from $638 million to $766 million this year and reach $1.45 billion by 1990, Miller forecasts.

Fueling PBX demand will be an increase in volume sales as well as a rise in prices on middle-level and high-end products

Another hot communications item is T-1 networks — multiplexer-based digital transmissions systems that can handle voice or data or both at bit rates of up to 1.544 megabits per second. Unlike the key telephone system market, the T-1 multiplexer business can tolerate all of the players, believes Powers of NBI. "Demand seems to be pulling capacity," he says of T-1 sales. His firm estimates domestic sales for T-1 equipment will grow at least 30% a year from the current $250 million level.

The demand for state-of-the-art communications equipment is also pulling along semiconductor capacity. "The communications circuits area is one of the hottest IC segments in the industry at this time," says Ronald Ruebusch, director of marketing at Advanced Micro Devices Inc.'s Communications Products Division in Austin, Texas.

The growth in the communications segment of the semiconductor industry has not slowed despite an otherwise depressed IC marketplace, Ruebusch points out. The AMD executive expects growth to continue in 1987, a year when chips designed for integrated services digital-network (ISDN) applications will no doubt occupy center stage. Ruebusch cautions, however, that 1987 will be a design and prototype year for ISDN chips — not a money-making year for them.

During 1987 U.S. consumption of integrated circuits (ICs) in communications equipment is expected to grow 19% from $2.89 billion to $3.45 billion, according to Gnostic Concepts. By 1990 this figure is forecast to hit $6 billion, says Edward Pullen, a research director at the San Mateo, California-based market research firm.

The increasing sophistication of software used to run communications systems will stimulate demand for more processing power and greater memory capability. Gnostic Concepts forecasts the consumption of microprocessor units (MPUs) in communications equipment will climb from $570 million in 1987 to $910 million in 1990. The use of memory ICs in such equipment, meanwhile, will rise — from $1.34 billion to $2.65 billion, respectively.

On the down side, the advent of an

all-digital communications network will eventually diminish linear IC demand. Gnostic Concepts figures the market for such ICs used in communications equipment will only expand from $530 million in 1987 to $860 million in 1990. "In the short term, both digital and analog components will coexist," Pullen says. His long-term view sees linear IC producers targeting niche markets.

Linear functions will always be around because the world exists in analog form, AMD's Ruebusch argues. He does, however, foresee a dramatic shift in the placement of linear ICs. As telephone companies digitize the inner circles of their telecommunications networks through the use of such equipment as digital CO switches, linear functions such as analog to digital conversion will migrate to the outer reaches of networks — at the end user's premises. So, he expects to see a lot of linear ICs designed into customer premises equipment.

Regulatory roulette

The Modification of Final Judgement (MFJ) is the anti-trust settlement that divested AT&T of its local Bell operating companies (BOCs), and limited specific lines of business that AT&T and the BOCs could operate within. Since the conditions of the MFJ took effect on January 1, 1984, the seven regional Bell holding companies (RHCs) have been chipping away piecemeal at a number of restrictions set in the decree.

But 1987 might become the year of the wholesale dissolution of the MFJ, which many communications equipment manufacturers fear will quickly put an end to open competition. If the MFJ is vacated, then one of its key restrictions — forbidding the BOCs to manufacture equipment — would be lifted with it.

Meanwhile, Congress, the Courts and the Federal Communications Commission (FCC) are pounding out their own ideas vis-a-vis deregulation. Senate Majority Leader Robert Dole (R-Kan.) introduced a bill last June (S.2565) that would shift the jurisdiction of the anti-trust settlement from the U.S. District Court to the FCC. Even though this bill died before coming up for a vote in the 99th Congress, it is expected to reemerge in 1987.

What concerns equipment manufacturers is that FCC Chairman Mark Fowler favors the lifting of BOC restrictions. "Nobody wants to compete against its best customer," says John J. McDonnell, vice president of the Electronic Industries Association's Information and Telecommunications Technologies Group.

Added to this web of complexities is District Court Judge Harold Greene's awaited review of the MFJ, which is scheduled to take place this year. In the past, Judge Greene has been generous in granting the BOCs a large percentage of their requests for waivers. The results of his review could mean anything from the lifting of more restrictions to a decision to vacate the decree altogether.

"If the BOCs are allowed to do whatever they want to do," says a spokesman for the Computer & Communications Industry Association in Arlington, Va., "we will see considerable change within the industry, including many bankruptcies." ☐

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OUTLOOK '87

Distribution: A go-go industry faces so-so growth

Distributors no longer are banking on a big year to bail them out. They're facing up to some sobering facts

By Fred McGrail

After a long wait, 1987 was to be the year of recovery for the U.S. electronics distribution industry. Unless there is dramatic growth in the overall economy and a quantum leap in computer sales, which now seems unlikely, 1987 will not be yet another year of waiting. Instead, it will be a year of adjusting — to a new reality for distributors.

"I don't call this a recession. This is now normal business," says Jack Darcy, president and chief executive of Diplomat Electronics. "We [did not] have a recovery year in '86, and I see nothing on the horizon."

Another realist is Joseph Semmer, chief operating officer at Hall-Mark Electronics Corp. "There will be no significant change into 1987," Semmer says, although he does expect his company to grow 5% to 10% this year. "Every time we turn around there's another excuse."

The excuses for distribution's poor performance in 1986 are likely to be offered again in 1987. They include the continuing movement of manufacturing operations offshore, disappointing results from major computer manufacturers, high inventories and pricing pressures from both suppliers and customers.

Hamilton/Avnet Electronics, the largest U.S. distributor, is expecting modest growth in 1987. "We don't see any sudden change in demand," says Ed Kaniger, vice president for worldwide operations at Hamilton/Avnet. Weak sales and profits of computer manufacturers, distributors' major customers, seem to justify Kaniger's lack of enthusiasm.

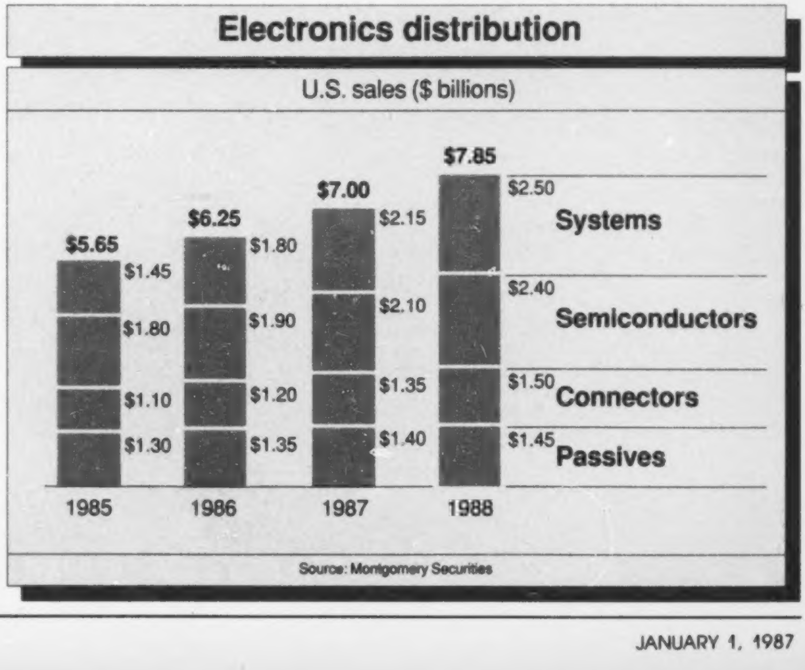
W. Donald Bell, president of Ducommun Inc., the parent company of distributor Kierulff Electronics, is bearish for 1987. "We came out of the summer with all the roar and energy of a mouse, and it looks like we'll stay that way," he says. "It's going to be a tough year. I can't see any turn up."

Not everyone is as pessimistic about distribution's prospects for growth in 1987. The National Electronic Distributors Association (NEDA), which estimates that U.S. distributors sold $6.5 billion worth of components and systems in 1986, foresees the industry expanding 12% in 1987, assuming the overall economy grows 2.5% to 3.5%. "It's not great news," says Toby Mack, NEDA executive vice president. "But it's the kind of growth rates we're looking at for the near to long term." Andrew Neff, an analyst with San Francisco-based Montgomery Securities, also forecasts growth of 12% for this year, coming on the heels of approximately half that growth in 1986.

Ralph Ozorkiewicz, a vice president at Wyle Laboratories and president for the company's Electronics Marketing Group, is looking for his group's revenue to increase 15% to 20%. He sees strength in microcomputer systems and peripherals and in the military market. In addition, he says, the success of Digital Equipment Corp.'s MicroVax II has opened up the computer-aided design, engineering and manufacturing markets for Wyle.

One reason for Ozorkiewicz's optimism is his belief that his customers' inventories are down. "We've had 18 to 24 months of inventory depletion," the Wyle executive says, implying that computer makers and other major customers are going to have to call on distributors for vital components in 1987.

Others, however, read the inventory situation differently. "There's lots of inventory yet to be used," says Hamilton/Avnet's Kaniger. "We, as a distributor, are sitting on inventory," says Hall-Mark's Semmer. "We're 30% overvalued in semiconductors," meaning that chips are selling for 30%



Source: Montgomery Securities

less than Hall-Mark's cost. NEDA's Mack observes: "Inventories are better than they were, but not good."

Ducommun's Bell thinks customer inventories are depleted, but says that it doesn't matter since lead times for components are short and parts are available. "Inventories are depleted, but they can get it [components] easily," he says. As for his company's inventories, Bell says they are high, with the exception of computer products.

Looking for new customers

The lack of activity by large computer manufacturers promises to keep a damper on semiconductor sales, which have traditionally accounted for about 40% of distributors' revenue. Semiconductor shipments to distributors will only increase 4% this year to $2.3 billion, predicts Jack Beedle, president of market research firm In-Stat Inc. "The mainframe manufacturers can soak up a lot of product," says Kaniger, who jokes that Hamilton/Avnet has done its part to stimulate mainframe sales with the purchase of an IBM 3090 model.

Distributors have been trying to offset the impact of the computer slump by finding new markets. Several companies, for example, rushed into military electronics — only to find it was less than the promised land. The rush to that market, along with tightened military procurement regulations, resulted in slashed profit margins and left some distributors complaining bitterly. Laments Hall-Mark's Semmer: "Our military sales are up, but our margins are down 2% to 3%."

Hamilton/Avnet's Kaniger wonders whether the stiff competition in the military market will really benefit the military. Despite the strong demand in the military market, he says, some established distributors may choose to leave it alone. "Profit is being reduced to such a point that it reduces interest in that market," Kaniger says. Still, the trend in military buying is toward multiple sourcing, doling out the business among many vendors.

Some distributors, in fact, blame military procedures, as much as cutthroat competition, for what they view as unacceptable profit margins. Wyle's Ozorkiewicz, for instance, believes that the military electronics business suffers from a "paralysis" as a result of government funding cuts. Kaniger says that the time and cost of complying with stringent military requirements makes the military business less attractive.

With pricing pressure intense in the military market and component sales sluggish in the computer market, the systems business has been critical to distributors' health. Distributors sales of computer systems and peripherals, which account for nearly 25% of total revenue, have held up despite the overall computer slump. "Microcomputer systems and peripherals have been strong," Ozorkiewicz confirms.

Some executives, however, see trouble ahead in systems — even in disk drives, one of the most lucrative peripherals for distributors. "I think we could have another semiconductor situation in the making," Ducommun's Bell says. "We may be filling up the pipeline, and then find there's no demand." Excess capacity is a potential threat, agrees analyst Neff. But he is confident that the demand for additional storage capacity by existing corporate owners of personal computers and workstations promises distributors continued growth in drive sales.

> The emergence of just-in-time manufacturing strategies could make the distributor's role more important

Fundamental problems

Despite the relative buoyancy of their computer businesses, distributors are still under pressure from their suppliers to accept lower profits and from their customers to cut prices. Analyst Neff is blunt about the seriousness of the price pressure's effect on the distribution industry. "The reason distributors are losing money is that they can't get their margins," he says. "Distribution traditionally had 25% margins. Now, no one has more than 22%."

Part of the distributors' problem is that the playing field is too crowded, at least from the distributors' viewpoint. Distribution accounts for about 28% of the total U.S. component sales, competing not only among themselves but with other sources of supply. One reason customers can demand lower prices from distributors is that they are not the only pipeline for components and systems. Hamilton/Avnet's Kaniger sums up the situation this way: "There are too many, offering too much, to too few."

One sign of hope for the distribution industry is the emergence of just-in-time (JIT) manufacturing strategies. JIT, which essentially means that manufacturers order parts only as needed rather than stocking inventory, could make the distributor's role more important, Wyle's Ozorkiewicz suggests. "Quality enhancement and just-in-time delivery programs could change relationships [between distributors and customers] from the transactional buy-sell," he says. "JIT means different things to different customers. What the distributor brings to the party is service."

JIT could prove a boon to distributors, NEDA's Mack agrees. "I think distributors are laughing up their sleeves when they hear all the talk about JIT," he says. "JIT has been distribution's business forever. There's no need to do any strategic adjusting."

But not everyone sees JIT as an opportunity. "Large manufacturers with forecasted schedules can best benefit from just-in-time," says Diplomat's Darcy, "but those people are not large users of products by distribution. JIT won't create business. Our customers selling their end product will create business."

But, if customers continue to move manufacturing operations overseas, it won't matter to U.S. distributors how much those manufacturers sell because they will be buying components offshore. "It's scary," says Hall-Mark's Semmer, and worst of all there is virtually nothing that distribution firms can do to stop this exodus. Distributors are also far from convinced that any trade agreements will have a significant impact.

The news from Washington, D.C., is not entirely bad, however. The new tax law, in fact, should benefit distributors. In the past they paid an effective federal income tax rate of more than 40% due to their asset structure, with most assets current, and because they had little capital equipment to write off. The 40% figure will decline with the new tax law.

Tax reform, however, may turn out to be a mixed blessing for distributors, suggests analyst Neff. Both suppliers and customers are expected to view the new tax law as a windfall to distributors, and additional pressure may be put on distributors' profit margins. "The question is," Neff says, "who is going to keep it?" ☐

European electronics: An uncertain start to 1987

Mainframe computer and semiconductor vendors may be wary, but PC and telecom makers are looking forward to the new year

By Jack Gee

The new year opens in an uncertain mood for Europe's electronics industry. Few signs of a revival are visible on the semiconductor front. An abrupt fall in sales of mainframe computers lies in prospect. A battle royal also could be looming in telecommunications if other countries follow the example set by the United States and Britain in deregulating this sector of the industry.

"However, the manufacturers of professional personal computers can look forward to another excellent year in Europe," says Gordon Curran, associate director of Intelligent Electronics, the Paris-based market study company. "Demand for their products is still a long way from saturation."

For the semiconductor manufacturers, the old year has ended on a drearier note, with distributors' warehouses still laden with stubbornly high inventories. In spite of the agreement between the United States and Japan to work together against dumping, prices in Europe have remained depressed.

The Europeans have taken particular umbrage at an arrangement which, they complain, was hammered out behind their backs. Voicing its irritation, the Common Market Commission in Brussels, Belgium, is challenging the validity of the U.S.-Japan pact in the framework of the General Agreement on Tariffs and Trade (GATT).

Original equipment manufacturers say they are giving priority to shedding existing stocks of chips and completing work already in process. "And, after that, we're all asking ourselves what will happen," says James Beveridge, associate director of Dataquest's European Semiconductor Division. "There's a strong possibility that semiconductor sales in Europe may grow by only 7% in 1987."

Continental computers

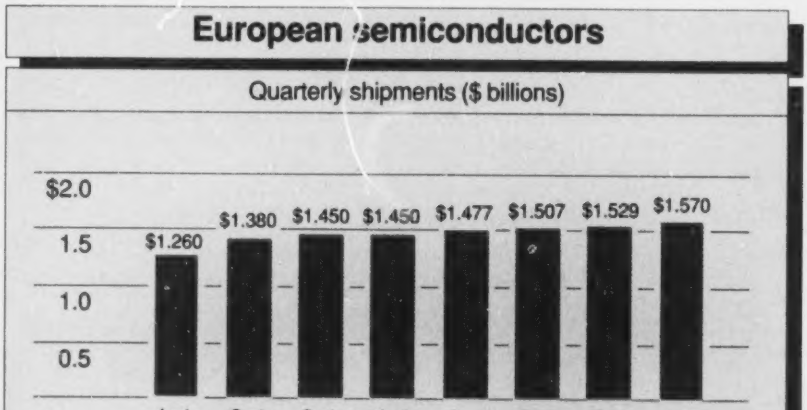
In contrast with their traditional practice, distributors failed to place orders during the last months of the year in the hope of doing seasonally good business at the start of the new year. Beveridge remarks: "The lack of confidence is visible throughout the semiconductor industry."

Faced by flagging demand for their own finished products, European computer systems makers are showing the same resistance to price increases for semiconductors as their counterparts on the other side of the Atlantic. Prices have stabilized in Europe following the establishment of prices for memory chips by the U.S. Department of Commerce in October.

The outlook is also gloomy for the mainframe computer market, particularly for IBM, the dominant contender. "It's difficult to see how IBM can avoid disappointing sales in Europe," says Emanuella Vitobello, a market analyst at International Data Corp.'s European headquarters in London.

IDC forecasts that IBM could see its installed base shrink between now and 1990 as networks of professional personal computers (PCs) burgeon in offices all over the continent. The market study group estimates that European sales of large multiuser processors — with price tags above $1 million — increased by 30% last year to $5,960 million. "But in 1987 sales are likely to rise by only 18%," Vitobello says. She stresses that Digital Equipment Corp.'s new VAX 8800 minicomputers are making inroads on traditional IBM sales in Europe. It is still premature to predict how the new IBM minis will perform in this arena.

However, there is a silver lining in the gray clouds that shroud the horizon of European electronics. Although growth rates are expected to be down from the previous year, the PC industry is likely to grow this year by a robust 25%, compared with 38% in 1986, according to Intelligent Electronics' Gordon Curran. He forecasts a particularly lively market for the nonprofessional range of Asian-made IBM PC clones priced between $500



European semiconductors

Quarterly shipments ($ billions)

Source: Dataquest Inc.

and $600. "These machines can be used for business," says Curran. "But their quality is not perceived as being up to the level required by corporate users."

At this lower end of the PC market, Intelligent Electronics expects strong sales in France, Germany and Britain. This last country is the home territory of the Armstrad PC, manufactured by London-based Armstrad Plc., which is storming its way into private homes in a style reminiscent of the Sinclair home computer, an earlier British design, at the end of the 1970s.

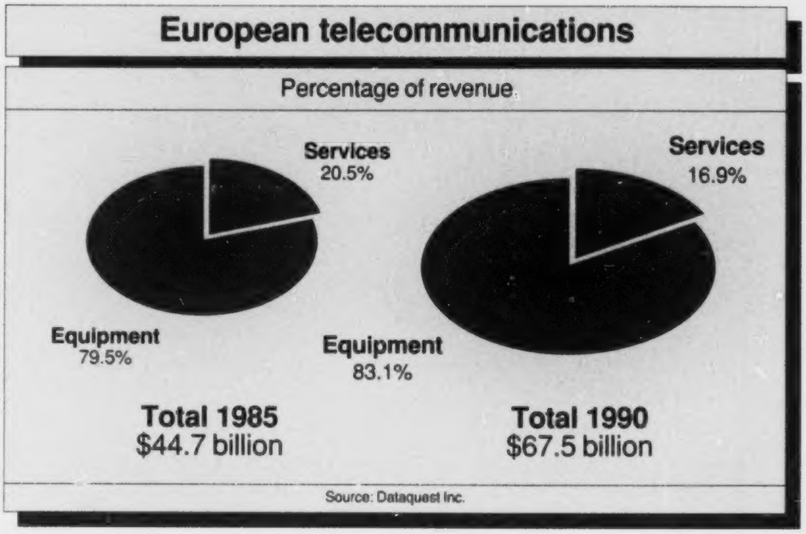
In the business sector, the big success story of 1987 is likely to be IBM's powerful AT model which last year boosted its share of the European PC market to 27% from 8% in 1985. "IBM may continue to lose market share to the clones among the less powerful PCs," says Curran. "But at the AT level they control 60% of the European sales."

With the introduction this year of new Microsoft software designed for Intel 80286-based models from IBM, Big Blue can look forward to highly successful business in Europe. In the computer-integrated manufacturing (CIM) sector, the IBM 6150, a high-powered PC for factory applications, will be challenged by a German rival, the Siemens PCD. "Germany is going to be the battleground because this is where the biggest CIM market in Europe lies," Curran says.

COMPAQ Computer Corp. is the first PC manufacturer to arrive in Europe with a 386 microprocessor model. But, in contrast to the United States, European buyers are likely to wait for IBM to present its own 32-bit PC before looking at COMPAQ or other makes.

Italy's Ing. C. Olivetti & Co. SpA, the No. 2 PC seller in Europe behind IBM, is expected to revamp its own range of PCs in 1987 in order to match those of the market leader. Already the price of the Italian M28, an AT equivalent, has been lowered to seek market share from IBM's XT 286. Reflecting a joint strategy devised with AT&T, which owns 25% of its equity, Olivetti is expected to incorporate a dual MS-DOS and Unix operating system in its new PC family.

Another successful performer in Europe is Apple Computer Inc.'s Macintosh which has increased its sales by 80% over the past year. The Mac owes its laurels to the strong takeoff by desktop publishing, first in Britain and more recently in France and Italy. Intelligent Electronics' Curran says: "Expect Mac to make good progress now that it's got its foot in the door of corporate Europe."


European telecommunications

Percentage of revenue

Source: Dataquest Inc.

Telecom testimonial

While Hewlett-Packard Co. fares well with its laser printers in the desktop publishing market targeted by Apple, L.M. Ericsson and N.V. Philips' GL and are still only scratching the surface of the European office computer market. Nothing indicates that the Dutch and Swedish makers will do better this year.

The optimism of the PC makers is shared by the telecommunications manufacturers

"Europe is a particularly sophisticated PC market," Curran says. "In contrast with the U.S., where many people bought PCs as fashion-type purchases, the Europeans have been slower, but more businesslike in their approach. There's been much less impulse buying here."

Only 8.3% of Europe's white-collar workers use a desktop machine, compared with 20% in the United States. "And European penetration won't reach U.S. levels for another three years or so," Curran predicts.

The optimism of the PC makers is shared by the telecommunications manufacturers. Their achievements in Europe this year will depend on a series of moves that are awaited over the next few months. Sometime this fall, the West German government is likely to announce the first steps toward breaking up the Bundespost, the powerful state-controlled telecom body. There are also rumors of timid steps toward deregulation in France. A long-delayed effort might be launched to standardize the continent's seven incompatible cellular radio systems.

"This could be a year of opportunities," says Edward Richardson, senior industry analyst with Dataquest's European Telecommunications Service. "With new steps toward deregulation of telecom in Europe, perhaps this terribly fragmented market might at last pull itself together." He adds: "If these trends are confirmed, our telecommunications market could be set for a period of expansion."

It is also likely to be a year of matchmaking as Europe's telecom manufacturers seek partnerships to consolidate their design, production and marketing power. Last year was marked by the marriage between International Telephone & Telegraph Co. and France's Compagnie Générale d'Eléctricite. Future elopements could involve such suitors (or blushing brides) as Britain's General Electric Co., Plessey Co. Plc. and Italy's Italtel SpA. "There could be quite a few surprises," Richardson remarks.

While their colleagues in the semiconductor and computer mainframe businesses watch anxiously for signs of a revival, the telecommunications and personal computer manufacturers can allow themselves great expectations for 1987 in Europe. □

U.S. in Japan: Computers are up, but the chips are down

There is still only a small group of U.S. electronics companies that are making it in Japan's marketplace

By Paula Doe

The favorable U.S. dollar exchange rate gave a boost to some established U.S. companies in Japan in 1985, which continued to do well in the steady Japanese computer market. But semiconductor makers took a drubbing. And the list of U.S. electronics companies that are actually making money in Japan remains soberingly short.

At 200 yen to the dollar as the 1985 year-end rate, everyone's results look 20% better than they did the previous year with a rate of 250 yen to the dollar. But yen-based sales of the top 30 U.S. companies in Japan were also up an average 17%. Twenty-three U.S. companies had sales of $100 million or more in Japan in 1985, compared with only 13 firms in 1984. And 10 companies earned $10 million or more in comparison with only four the year before.

Yen-based sales of the top 30 U.S. companies were up an average 17%

Still, Japanese electronics companies remain far bigger in the U.S. market than U.S. companies are in Japan. At least five big Japanese companies — Matsushita Electric Industrial Company Ltd., NEC Corp., Sony Corp., Sharp Corp. and Fujitsu Ltd. — had $1 billion or more in U.S. revenue in 1985. But only IBM Japan Ltd. and Fuji Xerox Company Ltd. cracked the billion-dollar sales mark in Japan. And Matsushita's $6.5 billion in U.S. sales dwarfed even IBM Japan's $4.6 billion in revenue. While the top five Japanese companies totaled U.S. sales of some $13 billion, all of the 30 top U.S. companies in Japan together managed only $12 billion sales.

ELECTRONIC BUSINESS tracks results of corporations in Japan that are at least 25% owned by U.S.-based electronics companies and releases their sales figures. This includes all U.S. subsidiaries and joint ventures that are publicly listed on any of the Japanese stock exchanges, and those which break out their Japanese subsidiary results for release to the press, Japanese corporate directories or market research firms. Dataquest Inc. of San Jose, Calif., supplies U.S. semiconductor producers' sales in Japan. Our listing does not include results of companies that sell through agents in Japan.

Top 10 U.S. companies in Japan

Rank	Company	Sales ($ millions)	Percentage change 1984/1985	Net income ($ millions)
1	**IBM Japan**	$4,573	+19%	$365.0
2	**Fuji Xerox**	$1,609	+13%	$74.6
3	**Nippon Univac**	$676	+11%	$14.2
4	**Texas Instruments Japan**	$560	-17%	-$21.3
5	**Commodore Japan**	$525	+5%	N/A
6	**Yokogawa-Hewlett-Packard**	$524	+17%	$29.3
7	**NCR Japan**	$511	+14%	$45.7
8	**Yamatake Honeywell**	$442	+13%	$14.3
9	**Sumitomo 3M**	$431	+14%	$12.7
10	**Burroughs**	$409	+1%	$20.0

Sources: Company reports, Toyo Keizai Shuppansha's *Kaisha Shikiho: Mijojo Kaisha Han*, Dataquest Inc.

Some big U.S. computer makers are doing better in Japan now than they have done in years, thanks to favorable exchange rates, growing Japanese demand, and plain old hard work. IBM Japan has recently been the focus of considerable Japanese attention due to its comeback, as its strong 19% revenue growth and 43% taxable income growth begins to make up ground lost to rivals Fujitsu and NEC.

Nihon Digital Equipment Corp. is also making a strong showing. Revenue and earnings were both up 42% for the fiscal year ending June 1985. Revenue was up another 25% for the year ending June 1986, to $332 million or ¥54.8 billion (¥165=$1), while pretax earnings soared by a factor of five, to $80 million or ¥13.2 billion, for a healthy 24% margin. The hot product driving this growth is the MicroVAX II workstation. Nihon DEC shipped 718 of these units last fiscal year.

Japanese productivity

Many U.S. companies are successfully taking advantage of the legendary Japanese productivity. Average sales per employee of the top 30 U.S. companies in Japan was $185,700, some 70% more than the $110,800 average of the ELECTRONIC BUSINESS 200 for 1985. Naturally the figures of the U.S. companies in Japan tend to

Top U.S. companies in Japan ranked by sales

Rank	Company	Sales		Percentage change 1984/1985	Net income ($ millions)	Net income as a percentage of sales	Exports as a percentage of sales
		($ millions)	(¥ millions)				
1	**IBM Japan**	$4,573	¥914,539	+19%	$365.0	8%	28%
2	**Fuji Xerox**	$1,609	¥321,701	+13%	$74.6	5%	18%
3	**Nippon Univac**	$676	¥135,182	+11%	$14.2	2%	0%
4	**Texas Instruments Japan**	$560[1]	¥112,043	-17%	-$21.3	-4%	43%
5	**Commodore Japan**	$525	¥105,000	+5%	N/A	N/A	N/A
6	**Yokogawa-Hewlett-Packard**	$524	¥104,899	+17%	$29.3	6%	10%
7	**NCR Japan**	$511	¥102,101	+14%	$45.7	9%	18%
8	**Yamatake Honeywell**	$442	¥88,383	+13%	$14.3	3%	22%
9	**Sumitomo 3M**	$431	¥86,138	+14%	$12.7	3%	N/A
10	**Burroughs**	$409	¥81,773	+1%	$20.0	5%	5%
11	**Mitsubishi Monsanto**	$360	¥71,904	+1%	$5.4	2%	N/A
12	**AMP (Japan)**	$252	¥50,420	+4%	N/A	N/A	N/A
13	**Nihon DEC**	$219	¥43,822	+42%	$3.7	2%	N/A
14	**Memorex Japan**	$137	¥27,338	+19%	$1.2	1%	N/A
15	**Nippon Data General**	$128	¥25,539	+78%	$2.0	2%	40%
16	**Yokogawa Medical Systems**	$116	¥23,208	+38%	$9.1	8%	30%
17	**Sony/Tektronix**	$114	¥22,770	N/A	N/A	N/A	N/A
18	**Nippon Avionics**	$114	¥22,739	+30%	$2.2	2%	N/A
19	**Nippon Univac Info. Systems***	$110	¥22,061	+26%	$0.5	<1%	N/A
20	**Nihon Business Computer**	$109	¥21,789	+93%	N/A	N/A	N/A
21	**Intel**	$108[2]	¥21,658	-21%	N/A	N/A	N/A
22	**Oki Univac**	$102	¥20,408	+63%	$1.4	1%	46%
23	**TEL-Thermco**	$102	¥20,318	+46%	$11.8	12%	0%
24	**Molex Japan**	$97	¥19,400	+7%	$13.5	14%	N/A
25	**Motorola**	$84[3]	¥16,898	-48%	N/A	N/A	N/A
26	**Mitsubishi Precision**	$74	¥14,735	+4%	$0.8	1%	N/A
27	**Applied Materials Japan**	$65	¥12,960	+5%	$1.9	3%	0%
28	**TEL-Varian**	$51	¥10,100	+23%	N/A	N/A	N/A
29	**Elco International**	$50	¥9,950	+8%	$4.5	9%	N/A
30	**Nemic-Lambda**	$50	¥9,932	-5%	$2.4	5%	N/A

All yen are converted at the 1985 year-end rate of ¥200 = $1 for purposes of comparison. Dollar results reported by companies whose fiscal years ended September, to November 1985 will be 1% to 9% lower than our figures due to the changing exchange rates. The actual end-of-period rates are as follows:

March 1985: ¥253 = $1
June 1985: ¥249 = $1
September 1985: ¥217 = $1
October 1985: ¥212 = $1
November 1985: ¥202 = $1
December 1985: ¥200 = $1
March 1986: ¥180 = $1
June 1986: ¥165 = $1

* Nippon Univac Information Systems

[1] Semiconductor sales in Japan were $319 million

[2] Semiconductor sales in Japan

[3] Semiconductor sales in Japan were $32 million

Productivity

Sales per employee	Net income per employee	Fiscal year ended	Contribution to parent company	Ownership
$244,700	$19,500	12/85	9%	IBM, 100%
$146,300	$6,800	10/85	9%	Rank Xerox, 50%; Fuji Shashin Film, 50%
$164,000	$3,500	3/86	4%	Sperry, 34.2%; Mitsui & Co., 34.2%
$119,200	$4,600	12/85	11%	Texas Instruments, 100%
N/A	N/A	6/86	N/A	Commodore Computer, 100%
$187,300	$10,500	10/85	6%	Hewlett-Packard, 75%; Yokogawa Hokushin, 25%
$117,300	$10,500	11/85	8%	NCR, 70%
$127,600	$4,200	9/85	3%	Honeywell, 50%
$211,100	$6,200	10/85	3%	3M, 50%; NEC, 25%; Sumitomo Electric Industrial, 25%
$154,300	$7,600	12/85	8%	Burroughs, 100%
$280,200	$4,200	12/85	3%	Mitsubishi Chemical, 51.2%; Monsanto, 48.8%
$241,000	N/A	12/85	15%	AMP, 100%
$133,600	$2,300	6/85	3%	DEC, 100%
$390,600	$3,300	12/85	2%[4]	Memorex, 60%; Kanematsu Gosho, 40%
$149,200	$2,400	9/85	9%	Data General, 85%; Kozo Design Laboratory, 12.6%
$178,500	$14,000	3/85	<1%	General Electric, 51%; Yogogawa Hokushin, 49%
N/A	N/A	N/A	4%	Sony, 50%; Tektronix, 50%
N/A	N/A	N/A	<1%[5]	NEC, 51%; Hughes, 49%
$172,400	$750	3/85	1%[6]	Nippon Univac, 100%
$93,100	N/A	3/85	<1%[7]	IBM Japan, 35%
N/A	N/A	12/85	7%	N/A
$160,500	$2,200	3/85	1%	Sperry, 45.1%; Oki Electric, 31.2%; Mitsui & Co., 15%; Mitsubishi Electric, 8%
$211,700	$24,600	9/85	N/A	TEL, 50%; Thermco, 50%
$104,300	$14,500	6/85	38%	Molex, 100%
N/A	N/A	12/85	2%	N/A
$86,400	$950	3/85	1%	Mitsubishi Electric, 42%; Singer, 40%; Mitsubishi Heavy Industries, 10%
$432,000	$12,500	10/85	37%	Applied Materials, 100%
N/A	N/A	9/85	2%	TEL, 50%; Varian, 50%
$199,000	$18,000	6/85	N/A	Wickes, 100%
$153,300	$7,500	9/85	24%	Veeco Instruments, 72%; Yoshihiro Madarame, 28%

[4] Percentage of revenue of Memorex parent, Burroughs
[5] Percentage of revenue of Hughes parent, General Motors
[6] Percentage of revenue of Nippon Univac parent, Sperry
[7] Percentage of revenue of IBM Japan parent, IBM

Contribution to parent is (percent ownership x Japanese subsidiary's sales) / parent sales
Ownership figures include those holders of 5% or more equity
N/A = not available

Sources: Company reports, Toyo Keizai Shuppansha's *Kaisha Shikiho: Mijojo Kaisha Han*, Dataquest Inc.

Top U.S. companies in Japan ranked by taxable income

Rank	Company	Taxable income ($ millions)	Taxable income (¥ millions)	Percentage change 1984/1985
1	**IBM Japan**	$780	¥155,983	+43.2%
2	**Fuji Xerox**	$160	¥32,005	-9.8%
3	**NCR Japan**	$91	¥18,118	+3.2%
4	**Yokogawa-Hewlett-Packard**	$47	¥9,335	-27.0%
5	**AMP (Japan)**	$37	¥7,419	-14.4%
6	**Yamatake Honeywell**	$37	¥7,399	+11.6%
7	**IBM Japan Sales**	$36	¥7,183	+0.4%
8	**Burroughs**	$33	¥6,510	-32.6%
9	**Nippon Univac**	$30	¥5,910	-1.2%
10	**Molex Japan**	$29	¥5,719	-6.1%
11	**Sony/Tektronix**	$28	¥5,524	+0.4%
12	**Yokogawa Medical Systems**	$26	¥5,288	+94.9%
13	**Sumitomo 3M**	$23	¥4,625	-20.1%
14	**TEL-Thermco**	$23	¥4,615	+32.8%
15	**Nihon DEC**	$15	¥3,039	+144.9%
16	**Mitsubishi Monsanto**	$14	¥2,813	-7.2%
17	**GE Technical Service****	$13	¥2,588	+20.0%
18	**Elco International**	$12	¥2,300	+3.2%
19	**Nippon Avionics**	$6.4	¥1,282	+24.6%
20	**TEL-Varian**	$6.4	¥1,272	+46.9%
21	**Nippon Tylan**	$4.4	¥886	+47.4%
22	**Shipley Far East**	$4.2	¥847	-28.2%
23	**Nemic-Lambda**	$4.0	¥809	-36.0%
24	**Nippon Data General**	$4.0	¥791	-28.2%
25	**Memorex Japan**	$3.9	¥772	-26.1%
26	**Analog Devices**	$3.9	¥770	-36.4%
27	**Applied Materials Japan**	$3.8	¥757	-40.3%
28	**Ampex Japan**	$3.2	¥641	+192.7%
29	**Nihon Business Computer**	$3.2	¥631	*
30	**TEL-Lam**	$2.5	¥497	+377.9%
31	**Mentor Graphics Japan**	$2.2	¥442	*
32	**Burr-Brown Japan**	$2.1	¥418	-4.3%
33	**TEL-Genrad**	$2.0	¥399	+12.7%
34	**Nippon Calcomp**	$2.0	¥393	-2.7%
35	**Teijin Memorex**	$1.9	¥389	-63.7%
36	**Mitsubishi Precision**	$1.9	¥381	+35.1%
37	**ITT Cannon**	$1.5	¥307	+553.2%
38	**Perkin-Elmer Japan**	$1.5***	¥298	*
39	**Apple Computer Japan**	$1.4	¥276	-32.7%
40	**Thomas & Betts Japan**	$1.3	¥258	-11.9%
41	**Burndy Japan**	$1.3	¥255	-78.9%
42	**General Instrument Japan**	$1.2	¥246	-72.2%
43	**Harris**	$1.2	¥242	*
44	**General Electric Japan**	$1.2	¥236	-48.9%
45	**Teledyne Japan**	$1.1	¥224	-8.2%
46	**Hirose Cherry Precision**	$1.0	¥199	-23.8%

Taxable income reported to the Japanese government for fiscal year 1985. Some figures may include tax losses carried forward from previous years.

All yen converted at ¥200 = $1 for purposes of comparison.

* 1984 taxable income less than ¥40 million ($163,000 at March 1985 rate of ¥245 = $1)

** General Electric Technical Service

*** Figures for partial year only because of change in company fiscal year

Sources: Company tax forms released by the Japanese government, compiled by Teikoku Data Bank, and published by Toyo Keizai Shuppan-sha in Hojin Shotoku 50,000 Sha Rankingu and Shukan Toyo Keizai: Kaisha Shikiho Mijojo Kaisha Han

be high because many of these subsidiaries merely sell products that are designed and produced in the United States. And subsidiaries are spared the weight of the parent's corporate staff and engineers. Still, even those subsidiaries of U.S. companies that produce most of their products in Japan, like IBM Japan, Texas Instruments Japan Ltd. and Fuji Xerox, have sales per employee roughly twice that of their U.S. parents. Many of these companies are effectively using Japanese managers and the dedicated Japanese workforce to build themselves an extremely efficient production base.

But very few U.S. companies are getting any major portion of their business from the Japanese market. Only five companies of the top 30 companies made as much as 10% of their sales in Japan. The average Japanese subsidiary's contribution to parent revenue was a mere 8%. Those doing the biggest proportion of their business in Japan tend to be those that supply components or equipment to the huge Japanese electronics sector rather than those that sell equipment or systems to end users. Sales of Molex Japan Company Ltd. came to 38% of Molex International Inc.'s total 1985 revenue. Applied Materials Japan Inc. contributed 37% to Applied Materials Inc.'s sales. And sales of Veeco Instrument Inc.'s 72%-owned joint venture Nemic-Lambda came to 24% of Veeco's total.

And, according to income-tax data released by the Japanese government, even fewer U.S. companies manage to make much money in the Japanese market. Although these pretax earnings figures include various loss carry-overs and tax credits, and doubtless a host of other creative accounting methods to reduce tax liabilities as well, figures are available for all businesses incorporated in Japan. But even with the boost from the favorable exchange rate, the list of U.S.-owned companies making real money in Japan is depressingly short. We found 46 companies that reported $1 million or more in taxable income to the Japanese government — presumably that translates roughly to a mere $500,000 in after-tax earnings. And only 18 companies earned $10 million or more before taxes.

More than half of the million-dollar club saw earnings drop, in 1985, by an average of 28%. But a few companies did see big gains, paced by ITT Cannon with 553%, TEL-Lam Ltd. with 378%, Ampex Japan Ltd. with 193%, and Nihon DEC with 145%. □

Image processing: Picture-perfect opportunities

Image processing may not be the next hula hoop, but the market has the same applications potential as the human eye

By David Card

Those murky shots of the H.M.S. *Titanic*'s anchor chains brought image processing into the public eye if not its vocabulary. Actually, the TV scenes would have been a lot murkier without filtering, just one of the applications of image-processing technology. Medical scanning and satellite snooping — two other applications — have been around for years. Machine vision, despite the bashing the robotics industry has taken, is a hungry consumer of image technology. Now, as single-chip processors become available and electronic publishing continues to be hot, the image-processing market should blossom.

Artificial vision propels image processing

U.S. sales ($ millions)

Market	1986	1990
Artificial vision	$191.3	$687.4
Graphic arts	102.7	256.4
Printing and publishing	108.5	234.4
Medical	64.5	132.5
Remote sensing	42.5	58.6
Geophysical	10.7	18.8
Other	60.2	188.3
Total	$580.4	$1,576.4

Source: Frost & Sullivan Inc.

THE MARKET

"Potential" is a word you hear a lot around the image-processing market. "It's not a horribly big market right now," says Albert Winegar, president of VICOM Systems Inc., "but potentially there are great opportunities." Last year, San Jose, California-based VICOM sold $15 million worth of its specialized image-processing computers and subsystems, Winegar says, mostly for medical and geological applications.

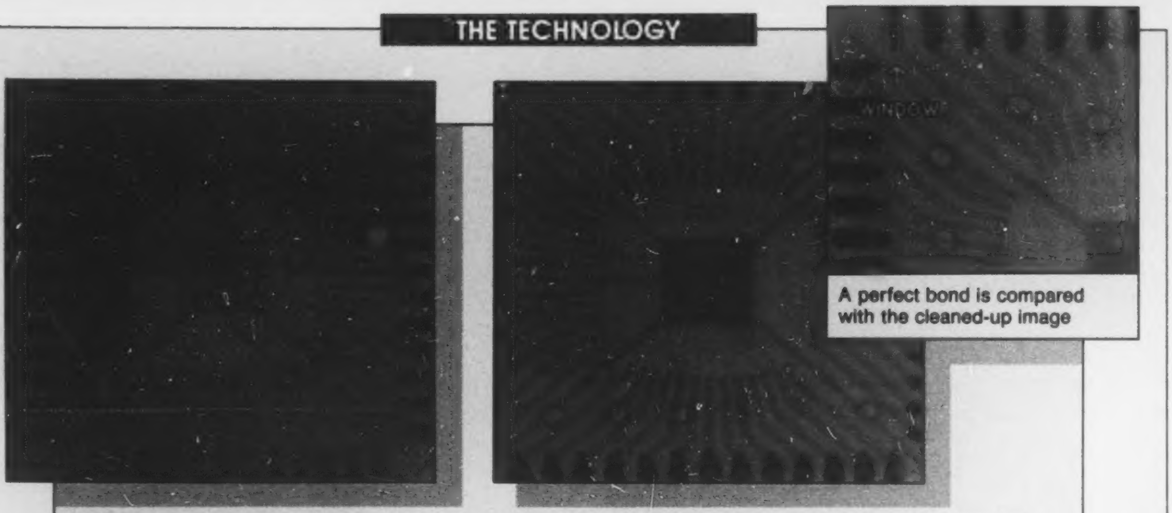
"It's the type of thing where you say: Where's the market? It's all fluff." adds Stephen Silver, president of Imaging Technology Inc. (ITI) in Woburn, Mass. But Silver says this mostly in reference to venture capitalists' disenchantment with the machine-vision industry — he thinks the potential applications for image processing could parallel those of human sight. "The industry in many ways is not big yet," Silver admits. "But the potential is enormous."

ITI competes somewhat with VICOM, selling add-on boards for personal computers (PCs). The company's subsystems were in part responsible for cleaning up the dramatic footage of the sunken *Titanic*. ITI had $11 million in 1986 sales, a relatively slow year, Silver says, because of those machine-vision vendors [ELECTRONIC BUSINESS Oct. 15, 1986 p52] that accounted for 16% of ITI's sales, a percentage that Silver expects to shrink.

The sales figures for the market for image-processing systems and subsystems are not too bad to begin with. The 1986 U.S. estimates range from Frost & Sullivan Inc.'s $580 million to The Yencharis Consulting Group's $966 million. Yencharis, out of North Masapequa, N.Y., forecasts 14% growth through 1988; New York City's Frost & Sullivan, 30.6% from 1985 to 1990. Richard Schwarz, a vice president at E.F. Hutton & Company Inc., points out that image processing, while taking hits due to the auto industry (General Motors Corp. cutbacks) and the oil slump, still held up better than most electronics segments.

Edward Carl, marketing vice president for Gould Inc.'s Imaging and Graphics Division in Fremont, Calif., breaks the image-processing market into seven segments. Gould sold $24 million worth of subsystems to the markets of graphic art, remote sensing (geological satellites), publishing, defense, research and development, medical, and industrial automation, he says, with most sales in graphics,

THE TECHNOLOGY



A perfect bond is compared with the cleaned-up image

IMAGE PROCESSING is at the heart of an IRT Corp. system for inspecting solder bonds of surface-mounted components. A "noisy" X ray (left) is cleaned up (right) by processing boards from ITI

Seeing more clearly

The technology of image processing arose early in the space race, when the unmanned Ranger 7 observed the moon. NASA scientists asked, "Why take up room on the tiny spacecraft with elaborate cameras?" They figured they could get by with a low-quality picture that could be digitally doctored when they received it back on earth.

The actual processing is only one component of a vision- or imaging-system. An image must be captured, often from a TV camera, and its analog light signals converted into digital pulses that a computer can handle. Image-processing algorithms — mathematical logic sequences embedded in hardware or written as software — manipulate the digital images before they are converted back into analog video pictures or printed out.

Image processing is a distinctly different technology from computer graphics, where the images are not from life but are man- or machine-made. Graphics are easier to manipulate than images because graphics are defined to a computer's "mind" as geometric figures — a set of points and a few other bits of information regarding shading or coloring. In contrast, a captured TV picture suitable for image processing contains some 200,000 individual picture elements, or pixels, each its own shade of gray or color.

Image processing uses some off-the-shelf hardware — converting light to electric charges via charge-coupled devices (CCDs) and crunching numbers with array processors — so it is the processing subsystems and their algorithms, often embedded in custom chips, that make up the value-added. These processes include highlighting, changing contrasts, moving, stretching, comparing and adding color to images.

For instance, to measure a drilled hole, the image processor takes the hole's image and converts all the pixels that are as dark as the hole to black and all those lighter to white. Then the vision system simply counts the black pixels. The real image-processing task is to make the artificial-intelligence job of pixel-counting easier. Another example would be overlaying an image of a newly finished circuit board on top of one known to be correct. If any chips were misplaced or misaligned, the algorithm recognizes and displays the mistake. ☐

publishing and defense. Gould technology helped defog the National Aeronautics and Space Administration's (NASA) probe into the *Challenger* disaster by filtering out smoke from video tapes. Carl says that profitability, rather than acquiring the technology, was the primary attraction behind Gould's acquisition of DeAnza Inc. a few years ago.

COST OF ENTRY

"There are barriers to entry," says E.F. Hutton's Schwarz. "Generally they're very low. There are barriers to survival — they ain't so low. And there are barriers to prosperity — they're high." The technology is not the limiting factor, Schwarz says, it is distribution. If the start-ups that populate the image-processing market cannot get the proverbial salesman's foot in the door, they are in trouble.

James McNaul, vice president of document scanner company Datacopy Corp., agrees entirely. Datacopy's case is different than that of the subsystems companies — scanners are sold as a peripheral to PCs, whereas subsystems are sold first to a systems integrator and then to the end user. Still, McNaul says funding the technology was the easy part. The Mountain View, Calif., company raised $4 million in venture capital, then about $9 million more in its initial public offering. The company has a joint development effort going on with Ricoh Company Ltd. But now McNaul's full-time duty is lining up distribution channels — original equipment manufacturers (OEMs) like Apollo Computer Inc., Interleaf Inc. and AM International's Varityper Division, and a host of dealers and value-added resellers.

McNaul says that although Datacopy is really only a high-end scanner maker, the company is forced to absorb the lower margins of medium-range scanners and even resell a low-end model to make the entire line attractive to dealers. "Dealers want

Photos courtesy of Imaging Technology Inc.

one supplier," he says. "But if we can train the dealer to sell the high-end products, the low-end is an easier sell — they'll go like peanuts." With volume comes profits, no matter what the margins.

ITI is a good example of a company getting into a market cheaply. The three-year-old company raised only $2.25 million in venture capital, bootstrapping its R&D by hitting profitability in its third month. ITI, however, did spend 18% of its sales on its own R&D last year, including over $1 million developing custom gate arrays. ITI's Silver says that 2.5 years ago he bought two computer-aided engineering workstations from Mentor Graphics Corp. and some more from Cadnetix Corp. to design chips and boards. He has the chips made by LSI Logic Corp. and is starting to second-source them from Toshiba Corp.

Although ITI does not build its chips, it does assemble the circuit boards they inhabit. To squeeze the boards into a PC's chassis, Silver went to surface-mounted components. This called for some $150,000 worth of special assembly equipment.

ITI's low sticker price — some boards cost under $2,000 — has resulted in a long list of customers and OEMs for ITI. Quad Systems Corp. of Huntington Valley, Pa., makes the kind of pick-and-place assembly equipment that ITI bought for its surface-mount facility. Quad chief financial officer Jeffrey Randall says that buying an image-processing subsystem involved "the same kind of decision as choosing a microprocessor for electromechanical gear." Quad buys from International Robomation Intelligence as well as ITI.

Synthetic Vision Systems, a supplier of high-end image processing computers out of Ann Arbor, Mich., broke off an OEM arrangement with VICOM and now buys some image-processing boards from ITI, according to director of sales and marketing Dave Trail. Early on, SVS saved some of the development costs of its visual inspection system by using core technology developed by a University of Michigan program. To develop a low-end entry into the image-processing market, even the deep-pocketed Minnesota Mining and Manufacturing Co. (3M) went to ITI to help out its Comtal/3M subsidiary in Pasadena, Calif. Comtal/3M makes general purpose image-processing systems with sales that are especially strong in the printing industry. Marketing operations director Karen Sauve says that Comtal/3M can better spend its development money on its high-end systems.

Liane Enkelis

VICOM's ALBERT WINEGAR: "Potentially there are great opportunities" in image processing

THE COMPETITION

Sellers of image-processing systems and subsystems — and there are hundreds, according to analysts — generally acknowledge that their stiffest competition comes from the internal development operations of potential customers, rather than from each other. Cognex Corp. of Needham, Mass., chose to bypass the middleman and build its own image-processing technology for its systems that visually inspect circuit boards. Allan Wallack, chief operating officer, says that if image-processing hardware were a commodity, with no potential for added value, he would buy it. The current offerings, he says, "are very, very general-purpose modules," with much more flexibility and power than he needs to do a given job.

Big companies will go to strategic partnerships to acquire the technology

In a similar vein, Datacopy's McNaul says: "Our feeling is that image processing is our core business and we don't want to lose control of it." The image resolutions that Datacopy works with are beyond the reach of ITI's current product offerings. ITI's Silver admits he cannot compete in every segment of the market, and he takes heart in the lack of large competitors — so far. "An interesting thing about this industry is that there are no major forces in the business," he says. "The big, quote, imaging companies, unquote, are not in the industry." ITI claims Eastman Kodak Co. and E.I. du Pont de Nemours and Co. as customers.

"At this point the industry is not big enough for them to be horribly interested," VICOM's Winegar says of the big computer companies. He also claims Kodak as a customer, as well as IBM and Digital Equipment Corp. "It's tough for a big company like Gould to be competitive in the low-end market and make its margins," admits Gould's Carl. E.F. Hutton's Schwarz agrees. "You're not going to roll out a general purpose image processor and do a billion dollars of business," he says.

Schwarz predicts that big companies will go to strategic partnerships to acquire the technology. He says that all of the companies out of the handful of image-processing firms that he considers the original pioneers — save VICOM — have been acquired. VICOM's Winegar points out that he has a large OEM agreement with General Electric Co. and that GE is an investor.

Still, analyst Leonard Yencharis thinks that imaging will be a major battleground for the computer giants, and E.F. Hutton's reports always mention the camera giants with hushed awe. Image processing, at least in its use of direct electronic translation of a real-life image to digital form — without conventional film — is a potential threat to camera and film companies. Kodak (which already owns scanner supplier Eikonix) and others may have to develop the technology defensively.

Gould's Carl sees two new potential competitors — Ramtek Corp. and Pixar. Ramtek makes imaging-display terminals and graphics workstations, and Pixar, Apple Computer founder Steven Jobs' latest project, is a special effects company — originally spun out of Lucasfilm Ltd., the brainchild of *Star Wars* creator George Lucas. Carl says the differences between graphics and imaging are rapidly dissolving.

It could be tough to keep the big guys out much longer. As Datacopy president Rolando Esteverena says of Xerox Corp.: "They're not so much a competitor as foregone business."

THE OBSTACLES

There does not appear to be all that much in the way of image processing as a technology. Still, a conventional drawback to young industries is always a lack of standards.

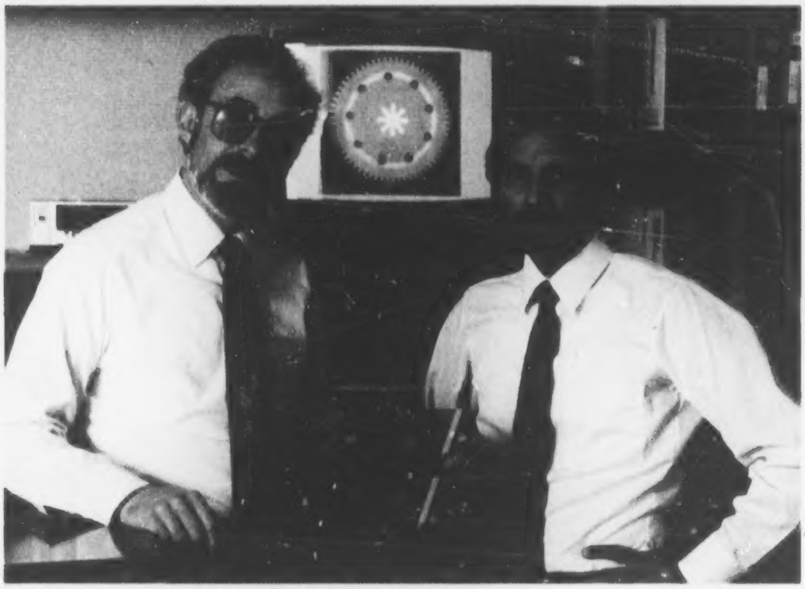
ITI's Silver says that a library exists consisting of 150 to 200 more or less generic image-processing algorithms. On the contrary, Gould's Carl contends that a lack of generic algorithms is one of the things holding back the industry, particularly the machine-vision segment.

Datacopy may have taken a step toward a conventional programming language, at least for scanners. The company is posing its PreScript as a counterpoint to the electronic-publishing industry's PostScript, from Adobe Systems Inc., the page-description language to drive laser printers. Whereas Postscript is used at the end of the publishing process, PreScript is used in the beginning — it breaks down a page for scanning, according to Datacopy president Esteverena.

Yet PostScript, as much a standard as possible, is opposed by a handful of the biggest publishing competitors. If Postscript's acceptance is analogous to PreScript's, then the language will need some heavy hitters behind it.

Besides standards, there are some key peripheral technologies crucial for the success of image processing. One is memory. A page of text scanned by pixels, when stored in a computer, takes a megabyte of storage. For comparison, that same page, stored the way a word processor would store it, takes one-twentieth of that space. Color images are three times as memory consuming. For mass storage, optical disks offer potential. "We're not ready to move to optical disks yet," cautions Sauve of Comtal/3M. "The technology just is not there." Locally, higher capacity memory chips — at low prices — are a must for image manipulation.

DATACOPY's ROLANDO ESTEVERENA: It could be tough to keep the big guys out much longer



ITI's Stephen Silver (left) and Rashid Beg: "An interesting thing about this industry is that there are no major forces in the business," says Silver

Other chips that support image processing are not so problematic. ITI's Silver says he has seen analog-to-digital converters drop in price from $700 to $50, and he crunches a lot of numbers with digital signal processors from Zoran Corp. He does admit, however, that most of his so-called library of algorithms were written for black and white images, and that some refinement for color is needed.

Matsushita Electric Industrial Co. of Osaka, Japan, has a new image-processing chip on the market. Masaharu Noyori, an administration manager for the company's semiconductor research center, says the chip is aimed at the factory automation field, specifically for production-line surveillance.

Overall, the obstacles to image processing are minimal, says Schwarz of E.F. Hutton. All the key technologies — image capture, analog conversion, processing, storage and display — are proceeding on their own. "There is a mini-industry pushing each one," Schwarz says. ☐

LEADTIME INDEX

Electronic component leadtimes

Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average	Last month's average
TRANSFORMERS								
Toroidal	7	27	47	13	6	0	8.1	8.1
Pot-Core	0	33	34	17	8	0	8.2	6.9
Laminate (power)	5	36	36	18	5	0	7.7	9.0
CONNECTORS								
Military panel	0	22	56	11	11	0	9.6	3.6
Flat/Cable	23	50	18	9	0	0	3.9	3.4
Multipin circular	7	13	60	13	7	0	8.9	4.0
PC	12	41	29	18	0	0	6.0	5.1
RF/Coaxial	23	53	6	18	0	0	4.4	1.8
Socket	17	48	22	13	0	0	4.7	4.7
Terminal blocks	15	48	33	4	0	0	4.2	4.1
Edge card	15	50	20	10	5	0	5.5	6.1
Subminiature	10	40	35	10	5	0	6.5	5.1
Rack & panel	8	46	31	15	0	0	5.8	7.4
Power	14	50	22	7	7	0	5.7	5.0
PRINTED CIRCUIT BOARDS								
Single-sided	0	50	45	5	0	0	5.4	4.9
Double-sided	0	62	38	0	0	0	4.3	5.1
Multilayer	0	30	57	13	0	0	7.2	7.1
Prototype	0	89	11	0	0	0	2.7	2.2
RESISTORS								
Carbon film	50	24	21	6	0	0	3.1	2.2
Carbon composition	37	21	21	21	0	0	5.4	4.0
Metal film	38	27	29	6	0	0	3.8	3.8
Metal oxide	36	18	37	0	9	0	5.6	5.3
Wirewound	25	17	46	8	4	0	6.4	7.7
Potentiometers	23	20	40	13	4	0	6.6	7.7
Networks	31	27	31	4	7	0	5.6	5.2
FUSES	48	23	26	3	0	0	3.0	2.7
SWITCHES								
Pushbutton	20	33	40	7	0	0	4.9	5.4
Rotary	5	45	45	5	0	0	5.3	6.1
Rocker	17	39	35	9	0	0	5.0	4.6
Thumbwheel	13	27	33	27	0	0	7.5	8.2
Snap action	33	25	33	8	0	0	4.5	6.9
Momentary	7	43	43	7	0	0	5.4	5.7
Dual in-line	17	41	25	17	0	0	5.5	5.7
WIRE AND CABLE								
Coaxial	44	22	28	6	0	0	3.6	1.9
Flat ribbon	30	44	22	0	4	0	3.6	2.5
Multiconductor	23	53	18	0	6	0	4.0	1.6
Hookup	48	42	10	0	0	0	1.7	1.5
Wire wrap	40	33	27	0	0	0	2.8	2.1
Power cords	25	36	32	7	0	0	4.4	3.5
Other	0	80	20	0	0	0	3.2	5.3
POWER SUPPLIES								
Switching	0	25	50	20	5	0	9.0	5.2
Linear	11	22	44	17	6	0	8.1	4.8
CIRCUIT BREAKERS	17	31	35	13	4	0	6.6	5.7
HEAT SINKS	24	40	28	8	0	0	4.3	3.5

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average	Last month's average
RELAYS								
General purpose	23	27	31	15	4	0	6.5	5.5
PC board	14	27	27	27	5	0	8.3	7.1
Dry reed	18	9	37	27	9	0	10.0	8.7
Mercury	11	22	22	34	0	11	11.0	6.0
Solid state	17	33	17	28	0	5	8.2	7.6
DISCRETE SEMICONDUCTORS								
Diode	39	21	32	5	3	0	4.5	3.4
Zener	30	28	30	12	0	0	4.9	5.0
Thyristor	19	38	25	12	6	0	6.4	4.5
Small signal transistor	35	15	25	20	0	5	7.1	5.1
FET, MOS	5	45	30	10	5	5	7.8	7.1
Power, bipolar	31	25	38	6	0	0	4.5	6.7
INTEGRATED CIRCUITS, DIGITAL								
CMOS	11	33	34	15	7	0	7.6	4.5
TTL	36	24	32	4	4	0	4.7	4.5
LS	29	26	37	4	4	0	5.0	4.3
INTEGRATED CIRCUITS, LINEAR								
Communication/circuit	14	14	58	7	7	0	7.9	4.0
OP amplifier	11	31	31	23	0	4	8.0	6.5
Voltage regulator	19	35	23	19	0	4	6.8	4.5
MEMORY CIRCUITS								
RAM 16k	17	25	33	17	0	8	8.4	4.6
RAM 64k	19	38	25	12	0	6	6.7	4.5
RAM 256k	23	12	47	12	0	6	7.7	5.8
ROM/PROM	25	8	50	8	0	9	8.0	7.2
EPROM	13	33	33	17	0	4	7.3	5.5
EEPROM	19	19	37	19	0	6	8.3	7.8
DISPLAYS								
Panel meters	13	40	40	0	7	0	5.7	5.6
Fluorescent	20	10	30	30	10	0	10.0	8.5
Incandescent	25	0	50	12	13	0	9.3	8.4
LED	14	36	39	7	4	0	5.9	4.9
Liquid crystal	7	7	66	20	0	0	8.7	7.8
MICROPROCESSOR ICs								
8-bit	25	19	38	12	0	6	7.3	7.1
16-bit	5	32	42	16	0	5	8.2	4.3
FUNCTION PACKAGES								
Amplifier	28	18	27	18	0	9	8.3	6.0
Converter, analog to digital	0	37	18	36	0	9	10.8	10.2
Converter, digital to analog	0	20	50	20	0	10	10.7	11.3
LINE FILTERS	9	36	37	9	9	0	7.5	5.3
CAPACITORS								
Ceramic	23	33	34	10	0	0	4.9	5.0
Ceramic monolithic	12	38	42	8	0	0	5.4	5.5
Ceramic disc	17	42	29	8	4	0	5.6	4.3
Film	19	27	31	23	0	0	6.7	4.4
Electrolytic	17	34	31	14	4	0	6.3	6.3
Tantalum	19	23	36	19	3	0	7.2	6.3
INDUCTORS	12	24	35	23	6	0	8.6	6.3

Source: *Electronics Purchasing* magazine's survey of buyers

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Electronic Business

An interview with IBM's manufacturing maestros

Outlook 1987: Purchasing strategies for the new year

The revitalization of U.S. electronics manufacturing

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BPA ABP

A yen to make communication equipment in the U.S.

Now that Japanese-manufactured equipment is more expensive, can U.S. companies compete?

Nitsuko Ltd. is a major Japanese manufacturer of telecommunications equipment, with plants in Japan and Taiwan. This company has a yen-based contract with TIE/communications Inc., valid through 1992, making Nitsuko TIE's sole supplier of key telephone systems. Back in 1984, when a dollar bought almost 250 yen, Nitsuko's equipment accounted for 36% of TIE's purchases, and gave the Shelton, Conn. company one of the leading shares of the key telephone systems market. Today, however, a dollar buys only 150 yen, making Nitsuko's equipment far more expensive and, according to TIE's chief executive officer Thomas L. Kelly, Jr., adversely affecting his company's sales and profitability. For the third quarter of 1986, TIE's sales dropped 20% with respect to the previous year.

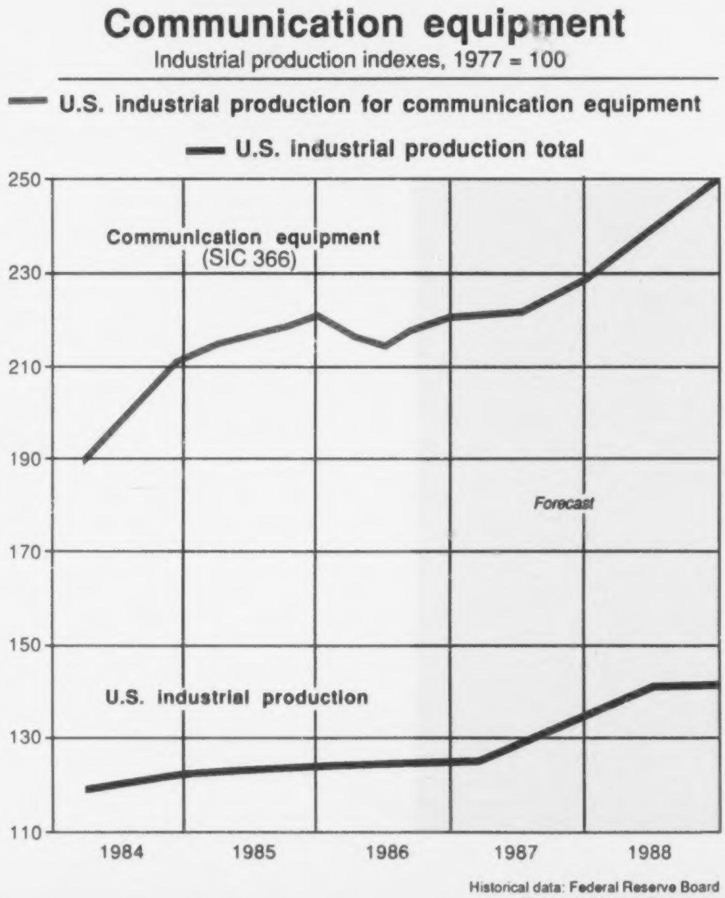
Conversely, Scientific-Atlanta Inc.'s sales were up 2% for the same quarter. This U.S. manufacturer of earth stations for communication satellites and of telemetry instrumentation has been helped by the demand for more, and more secure, satellite communication equipment and by the weaker dollar. SA's overseas sales for satcom equipment tripled in 1986.

TIE's and SA's business provide a glimpse of the U.S. communication business: the U.S. market continued to grow in 1986 and may do so again this year. Production of communication equipment in the United States did not grow in 1986, but may do so this year thanks to native technology and a more competitive dollar.

Not much growth, though. Cahners Economics forecasts that, after barely matching 1985's level in 1986, U.S. industrial production of communication equipment (SIC 366) will advance only 3% in 1987. Cahners economist Cheryl Patstone is more optimistic for 1988, forecasting a production growth of 8%.

The U.S. industrial production figures for communication equipment are strongly influenced by the major producer — AT&T — and reflect the production of AT&T's major telephone central office switch: the 5ESS. AT&T has been pushing the production of this switch to stem the inroads in its turf by major competitor Northern Telecom. The company has invested close to a quarter billion dollars in the past three years in Oklahoma City to build one of the most modern electronic assembly lines in the United States. The assembly line was set up for the purpose of manufacturing the 3B20 computer, which goes into the processor of the 5ESS as well as the switches themselves. But now automation is not enough to keep competitors at bay. Some new ones, especially the German telecom giant Siemens AG, have been moving aggressively into AT&T's communications turf. No wonder AT&T is now exploring offshore manufacturing, presumably with better cost protection than TIE got. But such a move by AT&T would keep the production figures from growing at least until 1988.

ALBERTO SOCOLOVSKY



Historical data: Federal Reserve Board
Forecast: Cahners Economics

New orders

Manufacturers of electrical machinery received an estimated $49 billion worth of orders in the third quarter of 1986, up from a total of $48.1 billion in the prior quarter. For the first nine months of the year, orders were up 4.4% compared with the same period of 1985. More than 60% of that increase resulted from a pickup in activity in the electronic component, television and radio segments of the industry. Demand for most other types of electrical machinery was running only slightly ahead of year-ago levels, and the communication equipment sector was actually 3.3% below the pace for the first nine months of 1985. All segments are expected to show an improvement in business conditions in 1987, especially during the second half of the year.

Unfilled orders

Manufacturers' order backlogs averaged $84.1 billion in last year's third quarter, unchanged from the level in the prior three months. When final fourth quarter figures become available, the year is expected to show an overall increase of just 2.3% compared with 1985. This will be the weakest annual performance since a mild loss was reported in 1975. Orders have already begun to strengthen in some segments of the electrical machinery industry, and most other areas are expected to see a corresponding turnaround sometime during the current year.

Shipments

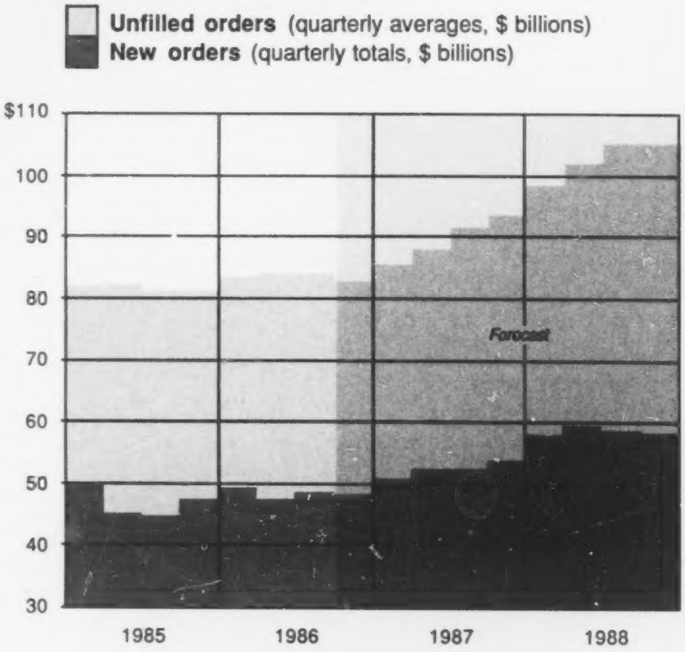
Electrical machinery manufacturers shipped an estimated $49.4 billion worth of products in the third quarter, an increase of 1.6% over the previous quarter and 9.2% over the third quarter of 1985. Gains in the communication equipment, radio and TV segments were responsible for nearly half of the growth in overall industry activity year to date. When final fourth quarter figures become available, industry-wide shipments should post a yearly gain of 4.2% to $193.4 billion. Although demand for military communication equipment has begun to slow recently, other product areas have seen signs of improved customer demand.

Inventory-to-shipments ratio

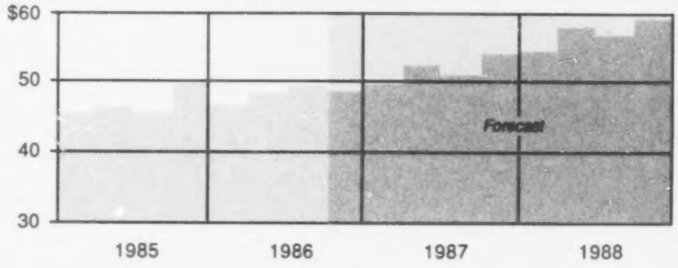
In last year's third quarter, inventories of raw materials, work-in-progress and finished goods, in the electrical machinery industry, rose by 1.7% to an average of $34.6 billion. Because this increase was balanced by a brisk rise in shipments, the industry's inventory-to-shipments (I/S) ratio moved sharply lower. It averaged just 2.07 during the period, down from 2.16 in the second quarter of the year. The latest reading is only slightly above the low of 1.96 reached at the business-cycle peak in early 1984, suggesting that inventory holdings are lean relative to shipments. A brief period of inventory accumulation is expected in early 1987.

Electrical machinery

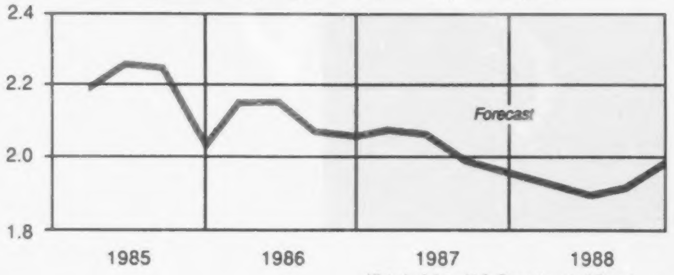
(SIC 36)



Electrical machinery: Shipments
(quarterly totals, $ billions)



Electrical machinery: Inventory-to-shipment ratio
(seasonally adjusted, quarterly averages)



Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

Electronic components and accessories
Producer prices for electronic components rose 1.0% in the third quarter of 1986, their sharpest increase in 18 months. Price increases, in product areas such as semiconductors and connectors, were responsible for the jump. Most other types of components showed little evidence of upward pressure. Prices are expected to show another moderate uptilt in the fourth quarter, bringing the yearly increase to 2%. This compares with a 2.4% rise in 1985. Accelerating market growth in 1987 and 1988 are expected to cause inflationary pressures to heat up once again. Prices should rise 3% this year and 3.4% in 1988.

Capacitors
Capacitor prices posted their seventh consecutive quarterly decrease in the third quarter of 1986, dipping approximately 1% below the level in the preceding three months. Two factors have been largely responsible for this downtrend: 1) intense global competition, and 2) sluggishness in the major electronic equipment end-user markets, which use capacitors in the production process. Prices are expected to begin moving upward in the fourth quarter, but declines earlier in 1986 will cause prices to fall 2.5% annually, as compared with a 1% drop in 1985. Look for prices to slip merely 0.7% this year and then to increase 1.1% next year.

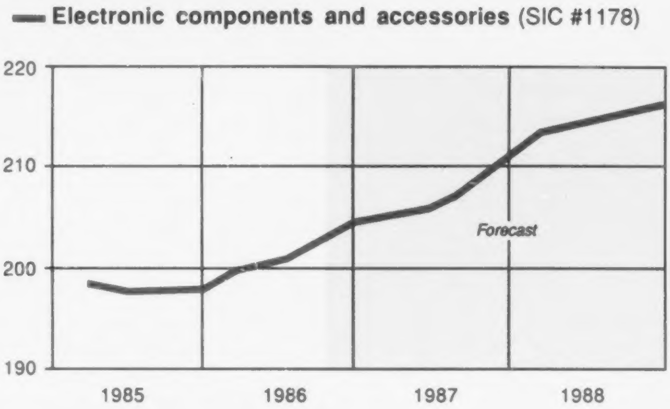
Resistors
After rising only 0.3% in the second quarter, resistor prices remained unchanged in the third quarter. This leveling off in prices was a reflection of the mid-1986 recession that occurred in most major industrial markets, low domestic inflation rates, and intense competition among resistor manufacturers. Up 2.0% year to date through September, resistor prices are expected to show about the same margin of increase for 1986 as a whole. A moderate rebound in demand this year will cause prices to rise about 2.7% annually. In 1988, look for a 1.1% increase.

Connectors
In the third quarter of 1986, producer prices for connectors jumped 1.3%. This matched the increase reported in the prior quarter but was up sharply from the gains recorded in late 1985 and early 1986. Another rise of about the same magnitude is expected in the fourth quarter; this will push prices up 3.6% annually compared with 1985, the biggest increase in five years. Although demand will be improving in 1987 and the underlying rate of U.S. inflation will be escalating, connector prices are expected to rise less rapidly than they did in 1986, probably 2.5% for the year. An increase of 3.3% should follow in 1988.

Producer price indexes

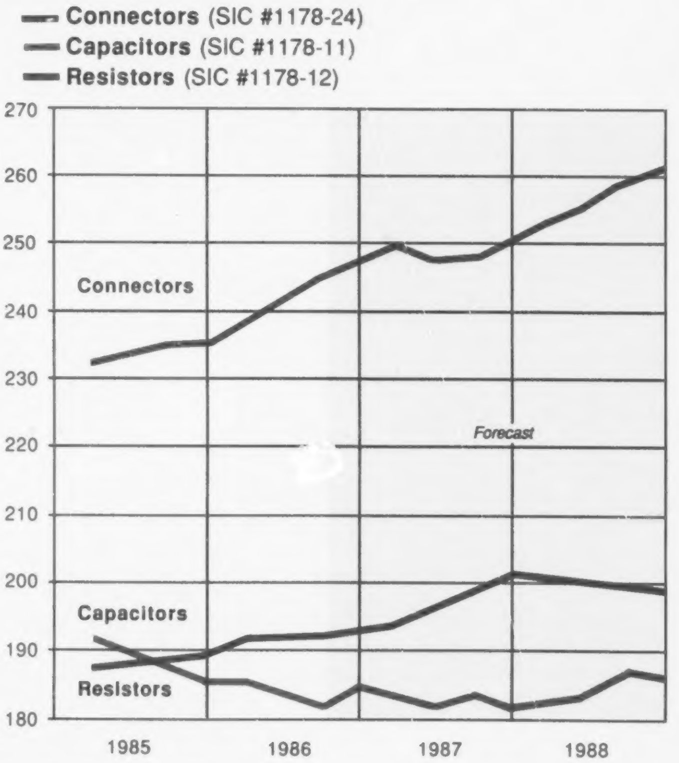
Electronic components

December 1967 = 100, quarterly averages



Passive components

December 1967 = 100, quarterly averages



Historical data: Bureau of Labor Statistics
Forecast: Cahners Economics

The Taiwanese government takes steps to aid industry

Like South Korea, Taiwan is trying to focus its efforts so it can continue to make its presence felt overseas

The entrepreneurial spirit is alive and well in Taiwan, and the government is worried. While a handful of South Korean multinationals are making deep inroads in the global electronics market, many in Taiwan, South Korea's chief rival for inexpensive assembly labor, are afraid the island nation may lose its competitive edge.

"In Taiwan, everybody wants to be their own boss," industry officials complain.Unlike South Korea, which has four big electronics-oriented conglomerates, or *chaebols*, linked to the government — Daewoo, Hyundai, Lucky-Goldstar and Samsung — Taiwan's $8 billion electronics industry consists of 2,300 mainly small, family-owned companies. Competing for Western original equipment manufacturers' (OEM) contracts, the Taiwanese electronics firms also frequently undercut each other's pricing, ensuring that no one company ever gets too big.

"South Korea is one-third the size of Taiwan [in area and half the size in population], but it has three car manufacturers, and we have eight. That ought to tell you something about competition in this country," says George Lie, an executive at Ching Fong Investment Co., a Taiwanese holding company which manages a portfolio of companies, including a local venture capital firm; Cogito U.S.A., a San Jose, Calif., disk drive manufacturer; and Sanyan Industry Co., a $250 million a year auto maker.

Jumping ship

Being small, most Taiwanese companies many times do not have the manufacturing, advertising and promotion budgets to effectively penetrate foreign markets the way the Korean *chaebols* can. "It's much easier to penetrate the European market than it is the States'," adds Simon J. Hsieh, manager of market planning for Microtek International Inc., makers of microcomputer in-circuit emulators. "It costs a lot of money to get your message out in the U.S."

In addition, managers in Taiwan often jump ship to form new companies, at a rate that would even make the heads spin of Silicon Valley's notorious job-jumpers. IBM and Apple Computer Inc. have teamed up to use their political, economic and legal clout to stop computer piracy. But with an average per capita income of $3,000, it is still easy to find cheap labor in Taiwan to build look-alike products.

To stablize the situation and instill some measure of centralized planning, the Taiwanese government is taking steps to protect the island's position as a low-cost supplier to the United States, Europe and Japan. Six years ago, the government set up the Science-Based Industrial Park in Hsinchu, near Taipei, to act as a home base for Taiwan's high-tech industries. Firms in the park work closely with the state-run Electronics Research and Service Organization to develop state-of-the-art Tawainese products.

More recently, the Institute for Information Industry, a quasi-governmental agency, hired market research firm Arthur D. Little Inc. in Cambridge, Mass., to identify key strategic areas for Taiwanese electronics manufacturers. A. D. Little singled out nine areas for the island to concentrate on — including (in software) business applications, expert systems and scientific applications; and (in hardware) facsimile machines, intelligent terminals, nonimpact printers, multifunctional workstations, Winchester disk drives and private branch exchanges.

Made in Taiwan

The government is also now encouraging Taiwanese firms to sell directly into Western countries under their own names, rather than private-label products. "We build products for all the major manufacturers — including IBM — but too often our products only show up in America with the words, 'Made in Taiwan' on them," says Irving T. Ho, president of the Institute for Information Industry. "So we're trying to convince our industry to also sell under our own brand names, to build brand awareness in foreign markets. Only in this way can we control our own destiny."

Brand awareness is also important because Tawian is afraid that rising protectionism in the United States, aimed primarily against Japan, could spill over into higher U.S. import tariffs for Taiwanese electronics equip-

Joseph Rupp

INSTITUTE OF INFORMATION INDUSTRY's HO: Taiwan must control its own destiny

Taiwan's widening trade deficit with the U.S.

($ billions)

	Imports	Exports
1981	$4.305	$8.049
1982	4.367	8.893
1983	4.667	11.204
1984	5.003	14.768
1985	4.700	16.396
1986	3.842	14.462

Source: U.S. Department of Commerce

ment. The U.S. trade deficit with Taiwan is now about $1 billion a month, primarily due to Taiwan's footwear and textile exports. But it is only a matter of time before America's beleaguered electronics industry also starts to complain, even though half of Taiwan's electronics output involves sales for captive operations for Digital Equipment Corp., IBM, Wang Laboratories Inc. and other U.S. manufacturers.

Meanwhile, though, Taiwan's annual trade surpluses are swelling Taiwan's foreign exchange reserves to $26 billion, making it easier for the country to offer incentives to emerging high-tech companies. The government, for example, can now purchase up to 49% of any start-up targeting what the government considers a strategic technology.

But it will take more than money to crack the U.S. market, as so many European electronics firms have learned in their unsuccessful efforts to grab a toehold in the United States. So Taiwanese companies are also taking a page from the Korean's book and starting to hire Americans to run their U.S. marketing and distribution operations. Mitac International Corp., for example, a $120 million a year personal computer maker, recently set up shop in Santa Clara, Calif., to sell its new line of IBM PC AT, and PC XT compatibles. As director of marketing, Mitac chose Philip D. Wood. Wood formerly worked for Leading Edge Hardware Products Inc. in Canton, Mass., a leading U.S. distributor of Daewoo personal computers.

AL FURST

Chip makers better keep TABs on their VLSI designs

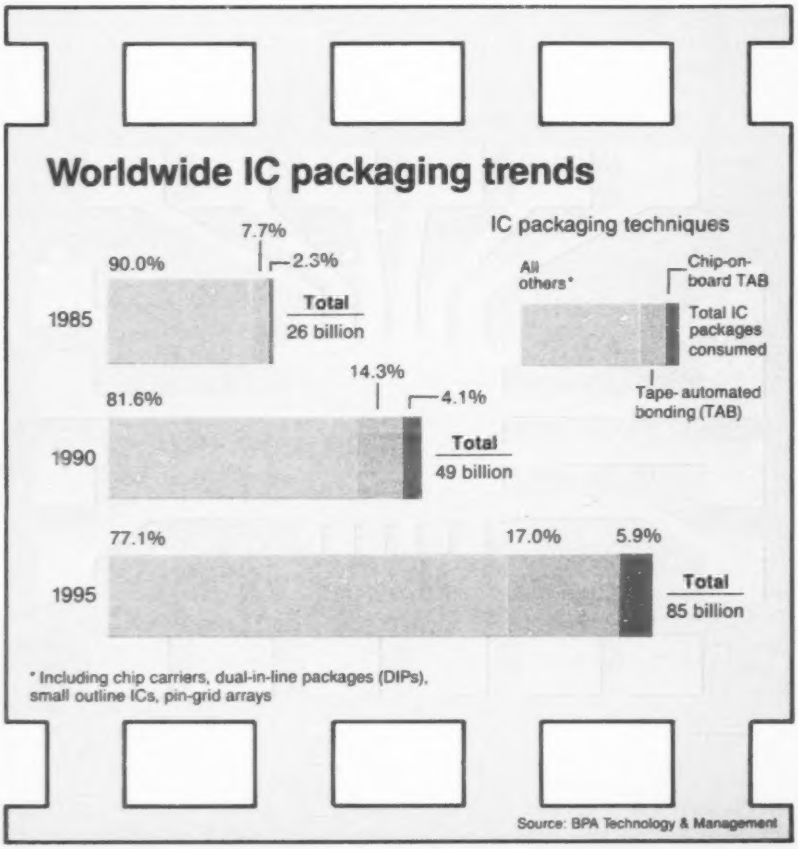
Semiconductor companies have spent a lot of money perfecting IC fabrication. It's time they invested in packaging

The next great frontier in microelectronics may well be development of the low cost, high reliability, high pin-count package. One trailblazer already has appeared on the horizon — tape automated bonding (TAB), a packaging technology expected to be in much wider use by the end of the decade.

One out of every seven integrated circuits built in 1990, industry observers predict, will be packaged using TAB — double its use in 1985. Such demand, in turn, is expected to spur demand for TAB materials, equipment and prototyping services — a nascent market currently sized anywhere between $25 million and $35 million.

What is driving IC manufacturers toward TAB technology are the limits of conventional packaging techniques. The very large scale integration (VLSI) devices being developed by those manufacturers demand superior packages — ones that can dissipate the heat and solve the other problems created by their new IC designs.

"The package is the real challenge," insists Harvey Miller of Kirk-Miller Associates, a market research firm in Palo Alto, Calif. Less challenging, he argues, is the actual fabrication of the integrated circuit — despite all the attention given to it. "With all due respect to the front-end process," Miller says, "gains there mean nothing if you can't produce packages that can carry away all the heat, allow for testing and provide interconnection of


Worldwide IC packaging trends

* Including chip carriers, dual-in-line packages (DIPs), small outline ICs, pin-grid arrays

Source: BPA Technology & Management

hundreds of leads, and do all this economically."

"The implementation of a high-performance package deserves a hell of a lot more attention," agrees Brian Hegarty, vice president and general manager of Honeywell Inc.'s Solid State Electronics Division in Colorado Springs, Colo. "The package limitations always define the [performance] limits of the device itself."

New generation packages

An IC package encases or surrounds a chip of silicon on which the integrated circuit is etched. Besides protecting the chip and dissipating its heat, the package serves to connect the device to a printed circuit board.

Today's prevalent packaging technology — the so-called dual in-line package (DIP) — involves attaching the individual chip to a "leadframe" strip (substrate) and using a gold wire bond to connect the leads of the IC to the frame. This assembly is then encapsulated in epoxy, and, after the leadframe is separated from the strip, the leads are formed. These leads provide connection of the assembled device to the outside world.

In the TAB process, however, the wire bonding step is eliminated. Essentially, "bumps," or elevated interconnection pads on the chip, are bonded with a simple heating tool to copper conductors on a leadframe. A so-called chip-on-board assembly is easily effected by connecting those copper conductors to the copper traces on a printed circuit board.

The advantages of TAB in certain applications — both low (14- and 16-lead) and high (80 and up) pin count — are numerous. For commodity devices such as memory ICs used in cars, the elimination of the intermediate wire bonding step allows for higher throughputs and ease of automation. National Semiconductor Corp. pioneered this application over a decade ago and last fall licensed its TAB technology to General Motors Corp.'s Delco Division. For more complex devices, TAB offers still greater technical advantages: lower inductance (and therefore a cleaner, faster signal); smaller bond pad size, a key to saving silicon space; shorter lead lengths (which makes TAB ideal for applications requiring flatness, such as "smart" cards); and the ability to ensure separation of the leads, a crucial factor when the leads number 200 or more.

TAB packaging was used on about 2 billion ICs in 1985 — representing 7.7% of the 26 billion ICs produced worldwide that year, estimates BPA Technology & Management, a Britain-based research firm. TAB use will grow to about 7 billion packages by 1990 — accounting for 14% of the total market, according to BPA. The use of TAB in chip-on-board assembly will more than triple in that time from 600 million devices in 1985 to 2 billion in 1990.

Smart cards will probably be the single biggest commercial application. Demand for these intelligent credit and security cards is expected to create a market for 500 million chip sets a year by 1990 in the United States, according to Smart Card Reports, an industry newsletter [ELECTRONIC BUSINESS, June 15, 1986 p26]. The first smart cards on the market do not offer enough functionality to require high lead-count TAB, but nearly all observers agree TAB will be necessary if smart cards are to achieve high-level intelligence.

TAB use will grow to about 7 million packages by 1990 accounting for 14% of the total market

International Micro Industries (IMI), a $4 million supplier of etched tape and equipment for TAB, three years ago spun out a new company, Smart Card Systems Inc., in an effort to vertically integrate. The spinoff already is bidding on a Department of Agriculture contract for 100,000 cards and is negotiating a marketing deal with a military contractor.

Thomas Angelucci, president of Cherry Hill, New Jersey-based IMI and the founder of Smart Card Systems, firmly believes he can leverage IMI's 16-year TAB history into the smart card business. "The office automation companies making smart cards don't understand the packaging," he claims. "We believe our multi-TAB packaging system can save $1 to $1.50 on each card, and we can realize additional savings by utilizing commercially available NMOS [negative-channel metal-oxide semiconductors] devices."

Meanwhile, the 1986 worldwide market for TAB materials, equipment and prototyping services is estimated at no more than $25 million to $35 million. In addition to IMI, U.S. materials suppliers include Minnesota Mining and Manufacturing (3M) Co. and Rogers Corp., which supply unetched tape; Olin Corp.'s Mesa Technology Unit; Micro Bond Technologies, a unit of Gould Inc.; and Koltron Corp., acquired earlier this year by Nippon Mining & Manufacturing of Japan. Mesa also markets TAB hardware from Siemens AG. Jade Corp. in Pennsylvania, the Swiss firm Farco SA, and the Japanese Shinkawa Ltd. are among those supplying equipment for gang bonding, soldering and handling TAB packages.

Major suppliers

Their customer base, however, has grown to at least several dozen. In addition to National Semiconductor, which has made by far the largest commitment to TAB, such merchant IC manufacturers as Fairchild Semiconductor Corp., Honeywell and VTC Inc. have made significant investments. The list of giant captive IC suppliers experimenting with TAB is much longer. It includes Apple Computer Inc., Cray Research Inc., Digital Equipment Corp., Ford Motor Corp., General Motors Corp., IBM and Unisys Corp. Areas in which high speed is important — supercomputers, advanced military silicon and gallium arsenide circuits — are the most fertile captive breeding grounds for TAB.

Nevertheless, some complain that the pace could be faster. "I don't see the big market they're talking about," says Larry Barber, a TAB product manager at Koltron. "There is a great deal of inertia out there, and the (TAB) technology is not proven in high volume for high lead-count devices."

A more prevalent view comes from Charles Turk, the president of Mesa. He is aiming at the TAB markets starting to emerge for high lead-count devices for gate arrays and very high speed integrated circuit (VHSIC) chips; for chip-on-board systems applications in Europe and Japan; and multichip packages.

"Don't make the traditional mistake of looking at the low-end cost-driven business as the real market," Turk cautions, speaking from experience. Mesa's original goal was to become a second source to 3M at National, but the start-up failed to get National's business. The misstep did not sour the Mesa executive on TAB, however. "If you can sell solutions to interconnect problems and not just tape or equipment," Turk says, "the potential is enormous."

MARK MEHLER

Dialing for dollars in the key telephone system market

Companies that can afford to manufacture in house or cut unnecessary distribution tiers may fare better than others

Today's $1 billion U.S. market for key telephone systems (KTS) — business telephone systems that offer special features — is no place for the faint hearted. The industry comes replete with all of the headaches of a commodity market — intense price pressures, slim profit margins and brutal competition.

"Because the market is so cost driven, a lot of interim levels of distribution are being squeezed out," notes Francis McInerney, analyst with New York City-based research firm Northern Business Information Inc.(NBI). To survive, McInerney suggests, vendors must be able to cut costs, either by manufacturing in house or by eliminating some levels of distribution costs.

Market leader AT&T has done well, for example, because of the company's tremendous strength in manufacturing expertise. The telecommunication equipment titan "has been able to develop very advanced and flexible automation," which, in turn, has allowed them to keep costs down, McInerney says. Although unit shipments by AT&T slipped slightly — to an estimated 1.1 million stations in 1985, down from 1.2 million stations in 1984 — McInerney believes that, in general, the company will be able to "hold steady" in a market expected to decline to $625 million in sales by 1990.

Toshiba is another player doing well. Paul Wexler, vice president and general manager for Toshiba America Inc.'s Telecommunication Systems Division in Tustin, Calif., attributes Toshiba's continued health to two factors. "We spend probably more time on distribution channels than on anything else," he says, and "95% or more of our product content is Toshiba-sourced."

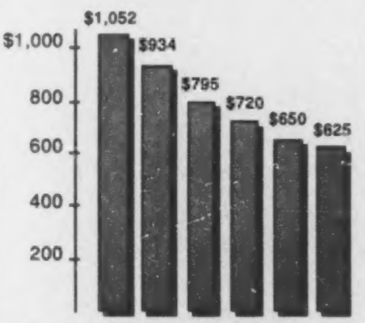
Shipments at Toshiba increased 45%, from 238,000 to 346,000, between 1984 and 1985, according to NBI estimates. Although Wexler does "not see the same growth in 1986 as in 1985," he does expect that once 1986 shipments are totaled, Toshiba's growth will be in the single digits, and will be significant. He also expects 1987 growth will be in the "same order of magnitude as 1986."

Customer focus

Very few key telephone system vendors, however, are in a position to make their own products. To prosper, they need to emphasize close customer ties. For example, ISOETECH Communications Inc., based in Darien, Conn., expects to post $60 million to $65 million in 1986 by emphasizing its distribution channels. Charles D. Kennedy, vice president of marketing, says the firm now has 11 direct sales offices and 29 exclusive regional distributors across the country. And outside the United States and Canada, Sweden's Ericsson Information Systems Communications Division will market ISOETECH gear under the Ericsson label. ISOETECH's concern with the customer's needs is what sold INMAC Corp. on ISOETECH equipment, says Bill Sultan, western regional manager of the computer and accessories catalog firm in Santa Clara, Calif. "We wanted someone flexible enough to change their programs to meet our needs," says Sultan, and "they spent a lot of time trying to understand our needs."

The U.S. key telephone systems market suffers a money crunch

Market size* ($ millions)



* Based on stations shipped

Source: Northern Business Information Inc.'s estimates

Another start-up that NBI's McInerney expects will do well is Shared Resource Exchange Inc. (SRX), based in Dallas. SRX manufactures its two product lines — key systems and private branch exchange (PBX) equipment — in the United States and it has distribution agreements with independent telephone companies and regional interconnects. SRX president, Eric L. Jones, is predicting 1987 shipments to be "about three times that of 1986." Last year, which was the company's first full year of shipping product, SRX shipped approximately 300 systems, according to Jones.

Pitfalls

For many manufacturers, however, the last few years have not been fun. The market's No. 2 sales performer in 1985, for example, — TIE/Communications Inc., based in Shelton, Conn., — suffered a loss of $10.9 million during the first nine months of 1986. In 1985, the company racked up a loss of $75 million. Unit shipments also declined to 750,000 in 1985, down from 1.037 million unit shipments in 1984, according to NBI estimates.

TIE, which at press time had not responded to repeated phone calls, has tried to get back on track in several ways. The company has purchased two equipment makers, Plessey Canada Ltd. and Turret Equipment Corp.; signed distribution agreements with all seven regional Bell operating companies (RBOCs); merged with distributor Technicom International Inc.; and acquired HCL Leasing Corp., a leasing firm that has since been sold. "Trying to move in too many ways at once killed the goose that laid the golden egg," NBI's McInerney says.

This confusing strategy has also trickled down to TIE's distribution channels. According to a former TIE distributor, Robert Hendershott, president of All-Tel Business Communications Inc., based in Kalispell, Mont., TIE "changed product too often for us to be able to keep up on it." As a result, Hendershott says that he "gave up on [distributing] TIE [products], and won't go back."

Overall, McInerney foresees 1987 as a "brutal" year for KTS vendors. The newer companies, he says, are being run by "real tough guys [who] are out to kill [and] the others, who aren't out to kill, will get killed."

CAROL SUBY

The new Congress takes another look at trade

With a $12 billion electronics trade deficit worldwide and a $20 billion deficit with Japan, the U.S. is looking for relief

As the new 100th Congress gets its house in order, the competitive stance of U.S. business is expected to be a key issue.

The U.S. balance of trade for electronic products and services continued to worsen through the first half of 1986. Assuming that the trade balance continued at the same rate for the second half, the U.S. deficit with the world was expected to exceed $12 billion and the deficit with Japan was projected to reach $20 billion, according to the American Electronics Association (AEA). In 1980, the electronics industry had a positive trade balance of $7.4 billion with the world and a negative trade balance with Japan of $3.9 billion.

The first step toward reversing the deteriorating condition of U.S. competitiveness is passage of a trade bill, according to Representative Jim Wright (D-Texas), majority leader of the House of Representatives. Wright says the House will start by introducing as H.R. 3 the omnibus trade bill passed by the House (but not the Senate) last year. The House vote was a bipartisan 295-115, despite the Reagan administration's opposition on some key portions of the bill.

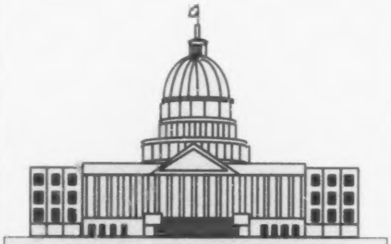
Now that the Democrats have wrested control of the Senate from the Republicans, the trade bill stands a better chance of approval. It remains unclear, however, what changes will be made before the proposed legislation makes it to the Senate floor.

The trade bill is not the only legislation expected to have an effect on electronics-related companies. Technical amendments to last year's massive tax reform bill also will be considered by the new Congress. It is not clear exactly what legislation will be introduced, but industry officials will be watching closely.

On the defense

The final tax reform bill that emerged in late summer was generally considered to be positive for the industry. While "loss of the capital gains differential is a negative," according to the AEA, "preservation of the research and development tax credit — albeit at a lower rate — will help many AEA companies, as will the preservation of export incentives and recognition of the short life of high-tech equipment for depreciation." And reduction of the overall corporate tax rate also is expected to benefit the industry.

Defense firms are waiting to see what the long-term impact of the Gramm-Rudman budget-balancing law will be on procurement. Early signs are that it will slow Pentagon acquisitions and eliminate some major programs. "Our members have seen some impact from Gramm-Rudman and they are expecting that it will accelerate," says Peter McCloskey, president of the Electronic Industries Association (EIA). "The 10-year forecast for defense electronics shows at most 2% annual growth."



The rising U.S. trade deficit in electronics products

($ billions)

	Exports	Imports	Balance
1981	$25.3	$19.3	+ $6.0
1982	26.0	21.0	+ 5.0
1983	27.9	26.7	+ 1.2
1984	32.8	39.0	- 6.2
1985	35.6	44.5	- 8.9
1986*	37.0	49.0	- 12.0

* ELECTRONIC BUSINESS estimate

Source: American Electronics Association

Congress, meanwhile, approved a $292 billion fiscal 1987 Defense Department budget as it raced to adjourn the 99th Congress. A compromise between earlier House and Senate bills, the defense authorization is about $28 billion lower than the Reagan Administration originally requested, but still slightly higher than the fiscal 1986 appropriation. Strategic Defense Initiative funding was held to $3.53 billion, significantly less than the $5.3 billion sought by the administration.

Computer and software firms anticipate introduction of several key bills relating to their industries. One bill, for example, would establish the Information Age Commission to consider the impact of computer and communications systems on society and act as a catalyst for change where necessary. The Information Age Commission passed the Senate but ran out of time in the House during the 99th Congress.

Software piracy

"It advocates a more comprehensive review of computer-related issues than the piecemeal approach of Congress so far," says Olga Grkavac, vice president, government relations of the Association of Data Processing Service Organization (ADAPSO). The Information Age Commission would create a forum for discussing such matters as intellectual property rights, computer education, computer crime and privacy.

ADAPSO also expects a software rental bill to be introduced next year. That bill would clarify laws preventing individuals from renting and illegally copying software. "Thou shalt not dupe" has become ADAPSO's motto, as the industry association struggles to protect intellectual property rights both nationally and internationally.

It remains uncertain just how much of an impact Democratic control of the Senate will have on important issues. "The key to what happens next are the economic numbers, not who controls the Senate," according to Susan Simon, a political analyst for E.F. Hutton. "For example, suppose the trade deficit [now at about $14 billion a month] heads back over $15 billion a month, then the newly elected will have to say or do something. They'll say, 'We have to pass a bill and take *ad hoc* protectionist action like we did in lumber and semiconductors.'"

BETH KARLIN

Equipment makers buy new designs, not new rules

Computer and communications companies are willing to invest in new chip technologies. But they'd prefer to unload trade laws

By Tim Mead
and Nancy McSharry

Heading into 1987, U.S. computer and communications companies are confident in the economy, uncertain about the new tax law and critical of trade barriers.

They will keep the bulk of their manufacturing onshore and in house. They will spend little more on semiconductor-related capital equipment. And they will dramatically increase their use of surface-mount technology (SMT).

Makers of minicomputers, multiplexers and the like also will buy 32-bit microprocessors in droves. They will design more custom integrated circuits into their systems. And they will take advantage of the performance characteristics of programmable memories.

Those trends and others emerged in a survey of engineering, production and operations managers conducted in late November by ELECTRONIC BUSINESS. The magazine focused on managers in U.S. computer and communications manufacturers because they buy half of all the electronic components sold in the United States. It narrowed its component-specific questions to semiconductors for the very same reason — they account for half the components purchased by U.S. equipment producers.

Macroeconomic views

Few surprises emerge when managers are asked how they view the general economy this year. Most are either optimistic (49%) or at least neutral (44%) about where the economy will head in 1987. A very small number (7%) actually believe it will decline.

Their opinions on the new tax law are mixed — but certainly not on the positive side. Only 6% of computer and communications executives actually believe the legislation will improve their companies' capital spending on plant and equipment. Fully 34% of them believe the law will have a negative impact, slightly less than the percentage (38%) who think the law will have no effect on such spending. An astounding 22% have no opinion whatsoever on the impact of tax reform.

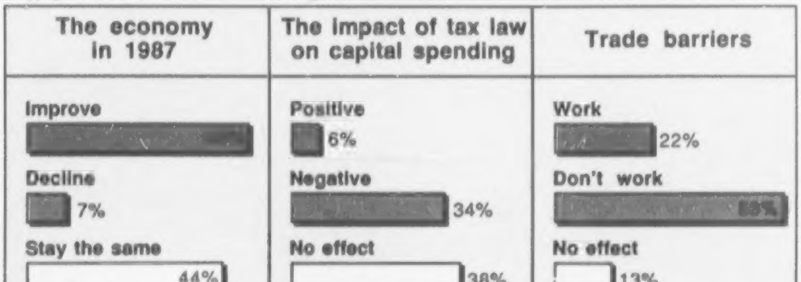
Government-imposed trade barriers do, however, elicit strong reactions from managers. More than half (53%) say such barriers don't work; only 22% believe they do. The remaining 25% either think trade restrictions have no impact or offer no opinion on the subject.

Most revealing, perhaps, is how much manufacturing will remain on U.S. soil and in the hands of the companies themselves. Managers at computer companies indicate that nearly 75% of the printed circuit boards (PCBs) used in their systems will be stuffed with components in the United States. Their communications counterparts have even closer ties to U.S. assembly, saying 85% of the finished PCBs that go into their products will bear the "Made in the U.S.A." label.

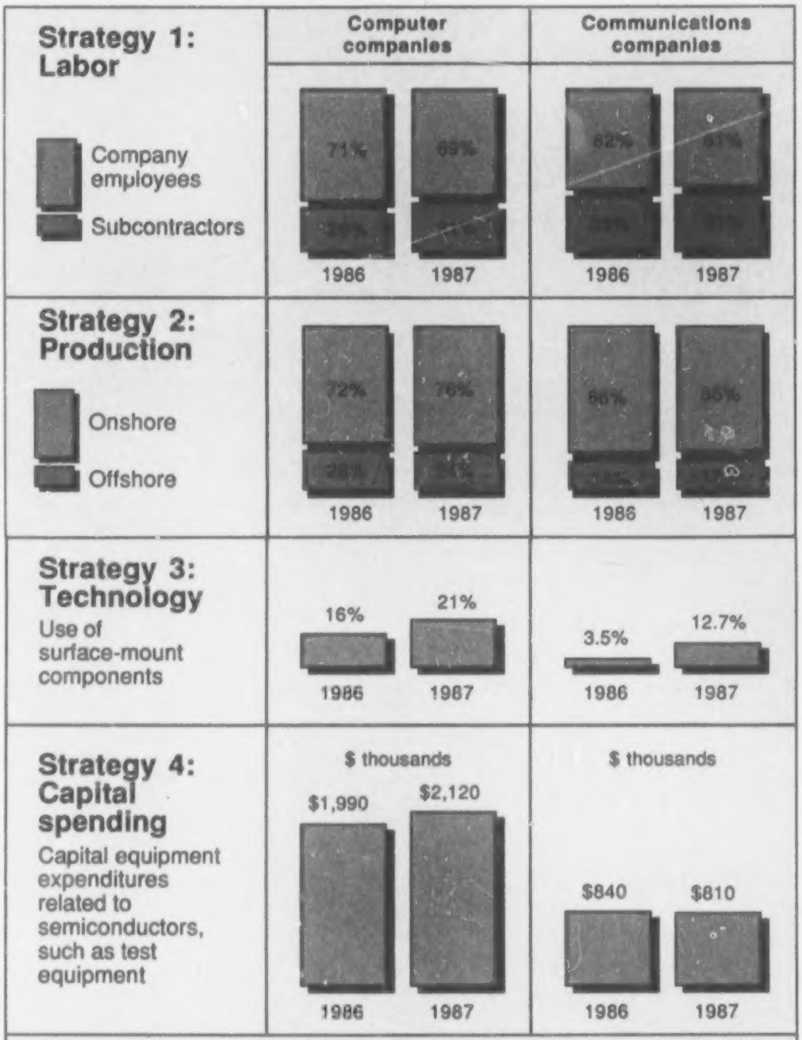
Both types of equipment makers will continue to produce the majority of their goods at their own factories. But somewhat surprisingly, manufacturers of datacommunications and telecommunications equipment are using subcontractors more than computer makers. Nearly 40% of the finished PCBs that go into modems and other types of communications gear come from subcontractors. Only 30% of those in computers are supplied by outsiders.

Despite the fact that 60% to 70% of manufacturing will remain within companies in 1987, they are not planning to significantly increase spending on semiconductor-related equipment.

An opinionated bunch— What managers at computer and communications companies think about:



Manufacturing strategies differ in degree, but computer and communications companies agree in substance



Expenditures are for an average company in each category. The average size of a computer company responding to the survey was $1 billion or higher in revenue. The average size of a communications company ranged between $50 million and $500 million in revenue.

The average computer company's outlay on such equipment will increase 7% this year, while the average communications company's spending actually may decline 4%. Such behavior is understandable, given that most computer and communications companies are now only using 70% of their existing manufacturing capacity. The loss of the investment tax credit, part of the new tax law, also is curbing capital spending.

One class of capital equipment that computer and communications companies will certainly buy, regardless of plant utilization or tax reform, is machinery used in conjunction with surface-mounted components. Computer managers expect that 21% of the semiconductors they use this year to be in SMT form — up from 16% last year. Their communications peers have somewhat lower expectations: Only 12.7% of the semiconductors they use are to be in SMT form in 1987 — up from 3.5% in 1986. SMT equipment makers would be wise to focus on computer and communications accounts with sales in excess of $50 million. Companies of such stature indicate the greatest willingness to use surface-mounted components.

What's hot, what's not

The "in" chip for 1987 is the 32-bit microprocessor. Nearly nine out of 10 managers (89%) at personal computer manufacturers indicate that their companies intend to use more 32-bit MPUs in 1987 than in 1986 — a statistic no doubt buoyed by the availability of Intel Corp.'s 80386 microprocessor. Interestingly, however, the popularity of 32-bit chips among PC makers will *not* be at the expense of 16-bit devices. Nearly as many managers (86%) say their companies plan to use more 16-bit MPUs this year than last; none of them say they intend to use fewer 16-bit chips in 1987.

There is evidence that 32-bit microprocessors will cannibalize 16-bit chip sales to manufacturers of board-level computers, workstations and minicomputer makers. Almost 10% of the managers at board-level computer makers plan to use fewer 16-bit products in 1987, while 75% of them intend to use more 32-bit chips. More than 20% of the managers at workstation and minicomputer companies say they will reduce their use of 16-bit MPUs this year; 75% of them, however, will use more 32-bit designs.

Communications companies also are eager to capture the power of 32-bit MPUs and their 16-bit predecessors. All of the managers at multiplexer, network, private-branch exchange, and central-office switch vendors indicate their companies will use at least 100% more 32-bit devices this year. And almost all of them plan on increasing the use of 16-bit chips by at least 50%.

Along with increased processing power comes demand for more sophisticated ways of managing memory. At least half of the managers in all five of the survey's computer categories indicate their companies will use more electrically erasable programmable read-only memories (EEPROMs) and simple EPROMs in 1987 than in 1986. Dynamic and static random-access memories (DRAMs and SRAMs) also will enjoy new popularity this year. In one category alone, minicomputer companies, as many as eight out of 10 managers say they'll use more DRAMs.

Semiconductor buying analysis
- Computer companies page 72
- Communications companies page 74

Computer companies: Will they use less, the same amount of, or more components?

Less Same More

	Board-level computers			PCs			Work-stations			Minis			Mainframes		
	Less	Same	More	Less	Same	More	Less	Same	More	Less	Same	More	Less	Same	More
Microprocessors															
8-bit	75%	13%	12%	60%	20%	20%		67%	33%	50%		50%	100%		
16-bit	9%	36%	55%		14%	86%	23%	6%	71%	28%	28%	44%		50%	50%
32-bit		25%	75%		11%	89%		25%	75%		25%	75%	12%	25%	63%
Memories															
DRAM		50%	50%		23%	77%		29%	71%		17%	83%		25%	75%
SRAM	14%	43%	43%		29%	71%		40%	60%		25%	75%		25%	75%
EPROM/ EEPROM	9%	18%	73%	10%	30%	60%	10%	30%	60%	20%	20%	60%	25%	25%	50%
ROM	11%	33%	56%		50%	50%		40%	60%	20%	40%	40%	25%	25%	50%
Logic ICs															
TTL	14%	29%	57%	18%	16%	66%		22%	78%	40%	20%	40%	50%	25%	25%
ECL	25%	50%	25%	25%	25%	50%		20%	80%		25%	75%		25%	75%
Custom ICs															
Gate arrays		37%	63%	11%	22%	67%		18%	82%			100%		20%	80%
Standard cells		50%	50%	14%	29%	57%	24%	13%	63%	25%	25%	50%		33%	67%
Linear ICs	16%	67%	17%	28%	43%	29%	11%	56%	33%	20%	60%	20%		67%	33%

Communications companies: Will they use less, the same amount of, or more components?

◀ Less Same ▶ More

		Modems	Multiplexers	LANs	PBXs	CO Switches
Microprocessors	8-bit	100%	33% ▶67%	50% ▶50%	100%	100%
	16-bit	50% ▶50%	▶100%	20% ▶80%	◀50% ▶50%	33% ▶67%
	32-bit	NA	▶100%	▶100%	▶100%	▶100%
Memories	DRAM	◀20% 60% ▶20%	67% ▶33%	100%	100%	33% ▶67%
	SRAM	50% ▶50%	25% ▶75%	50% ▶50%	100%	50% ▶50%
	EPROM/ EEPROM	40% ▶60%	17% ▶83%	20% ▶80%	33% ▶67%	33% ▶67%
	ROM	75% ▶25%	25% ▶75%	67% ▶33%	33% ▶67%	33% ▶67%
Logic ICs	TTL	40% ▶60%	20% ▶80%	◀17% 33% ▶50%	33% ▶67%	100%
	ECL	◀50% 50%	◀25% ▶75%	◀20% ▶80%	▶100%	▶100%
Custom ICs	Gate arrays	▶100%	▶100%	20% ▶80%	▶100%	▶100%
	Standard cells	▶100%	▶100%	50% ▶50%	▶100%	▶100%
	Linear ICs	60% ▶40%	40% ▶60%	◀25% 50% ▶25%	33% ▶67%	33% ▶67%

The bus battle moves to a 32-bit arena

The board-level market continues to bristle with competing bus structures as it surpasses $1 billion in sales

By Anne Knowles

Ever since 32-bit microprocessors became a reality, industry watchers have been waiting for the battle between 32-bit buses to begin. In one corner, say observers, stands Motorola Corp., maker of the 32-bit 68020 chip and developer of VMEbus, the leading 32-bit bus architecture. In the opposite corner is Intel Corp., manufacturer of the 80386 microprocessor and designer of Multibus II. And in the middle is a billion-dollar business.

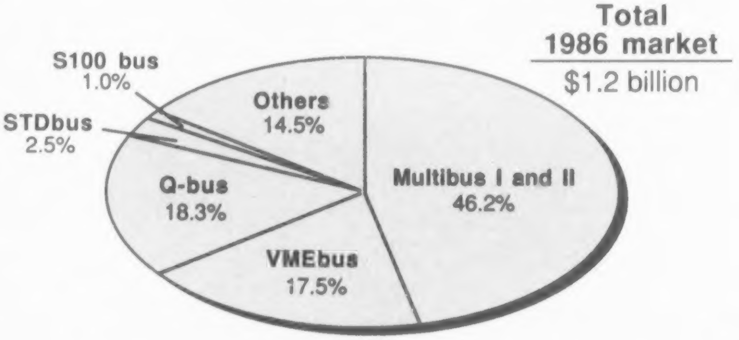
That billion-dollar business is board-level microcomputer products, which Gnostic Concepts Inc., a market research firm in San Mateo, Calif., estimates reached $1.2 billion in worldwide revenue last year. Hundreds of vendors sell board-level products based on standard bus architectures — the network of connections that link components across a board. Some sell central processing unit (CPU) boards using off-the-shelf microprocessors and open bus structures. Others market add-on boards, such as input/output boards, that are compatible with leading bus architectures, such as Q-bus, Digital Equipment Corp.'s 16-bit bus structure.

In the 16-bit board-level world, DEC's Q-bus and Intel Corp.'s Multibus I are the leading contenders. The two bus architectures have captured about 80% of the 16-bit board-level market between them. "We've seen a lot of buses come and go," says Robert Hughes, executive director of the Multibus Manufacturers Association, in Portland, Ore. The reason for the historical dominance of the two bus architectures, says Hughes, is that most board-level vendors choose a standard that is being ported by at least one major manufacturer.

> At stake for Motorola and Intel is more than just a pledge of loyalty from a handful of vendors

Worldwide board level shipments hit $1 billion in 1986

Share of 1986 market by product



Source: Gnostic Concepts

Because of that, observers expect the same shakedown to occur in the maturing 32-bit market. Futurebus, a 32-bit bus developed and promoted by the Institute of Electrical and Electronic Engineers; and NuBus, designed at Massachusetts Institute of Technology, further developed by Western Digital Corp. and acquired by Texas Instruments for its Nu Machine; lack the corporate backing, says Hughes, to gain much market share.

DEC's 32-bit BIbus, announced last year, certainly has the support it needs. But most analysts say it will not have an effect on the war between open bus structures. "Very few vendors would think of doing board-level products," based on DEC's BIbus, says Robert Herwick, an analyst with Hambrecht & Quist in New York City. And for its part, says Hughes, DEC is not interested in attracting board-level competitors.

Most board-level vendors, say observers, will choose between Motorola's VMEbus and Intel's Multibus II, two open 32-bit bus architectures backed by major microprocessor makers. What has yet to be determined is which bus structure will come out on top.

At stake for Motorola and Intel is more than just a pledge of loyalty from a handful of vendors. Some argue that bus architectures sell microprocessors, microprocessors sell bus structures and so on. "Certainly the more 80386s sold, the more Multibus IIs sold," says Hughes. And the more vendors that support Multibus II, the more Intel can sell 32-bit chips, says Hughes.

That may partially explain why, to date, there has not been much of a 32-bit bus battle. VMEbus, designed by Motorola, Mostek, Philips/Signetics and Thompson CSF and introduced in late 1981, has captured the lion's share of the nascent 32-bit board-level market. Over 120 vendors manufacturing over 600 products sell VMEbus-based boards, while only about 75 manufacturers making 130 different boards sell Multibus II-based products.

Motorola also has leading market share in the 32-bit microprocessor market. In 1985, according to Dataquest Inc., a market research firm in San Jose, Calif., Motorola's 68020 garnered 60% of the $16.8 million market for 32-bit microprocessors. But a year later, and a year after Intel's 80386 was unveiled, Motorola's share of the 32-bit microprocessor market shrunk to 50% while Intel appeared in the rankings with an 18% slice of the 1986 $59 million market. "There are great expectations for the 80386," says Hambrecht & Quist's Herwick. "Multibus II is gaining momentum."

But bus structures and microprocessors are not inextricably linked. While Multibus II was designed with Intel's 80386 in mind, and VMEbus developed for Motorola's 68020, both buses can be used with other microprocessors. And 32-bit chips can be put on 16-bit buses. Steven Cooper, product marketing manager for Intel's original equipment manufacturer (OEM) module operations, estimates that about two-thirds of the 80386s that are being bought by vendors are designed onto Intel's Multibus I, 16-bit bus architecture.

Microprocessors, however, are not the only products Intel and Motorola sell. For both companies, bus architectures have a more concrete connection to the bottom line. At Intel and Motorola, board-level products have become a multimillion dollar business. Both companies initially began selling board-level products in order to sell more chips, says Hughes. "But when [the market] began to hit $100 million each company made a separate business unit," for board-level products, he says.

Intel's board business

At Intel, for example, board-level products represented 8%, or $109 million, of the company's 1985 $1.36 billion revenue. And it is growing. Between the first and last quarters of 1986, says Robert Hanson, Intel's general manager of OEM modules operations, the board business grew exponentially, by a factor of five.

Board-level products are vital to Motorola, too. While the company will not break down its revenue by product, Motorola is the top vendor of VMEbus-based board-level products. According to Frost & Sullivan Inc., a market research firm in New York City, Motorola heads the list of VMEbus makers with 21.2%, or $44.5 million, of the $210 million market for VMEbus board products.

Another leading VMEbus products vendor contends that Motorola's board-level zeal has made life difficult in the VMEbus market. DY-4 Systems Inc., in Ontario, Canada, makes ruggedized VMEbus boards for military, telecommunications and industrial automation applications. Says Terry Black, DY-4's vice president of sales and marketing, "Motorola has been aggressively buying market share at the expense of profits."

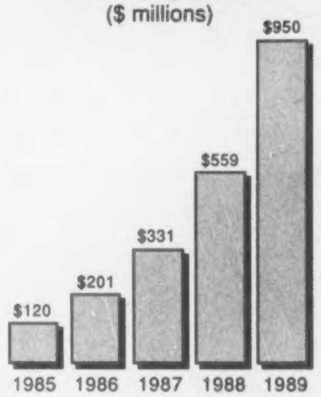
Jeffrey Gorin, Motorola's manager of product applications in the microcomputer division, disagrees. Three years ago, Motorola initially introduced midrange board-level products, explains Gorin. Since then, says Gorin, manufacturing costs have come down, component prices have dropped and Motorola has filled out its line of products with both low-end and high-end offerings. All that amounts to is a 6% to 25% drop in board-level prices, says Gorin, not price slashing.

But Motorola may soon have its hands full with Intel and other Multibus II manufacturers. Market figures for both VMEbus and Multibus II are difficult to come by and analysts rarely agree. All analysts concede, though, that VMEbus products now control the 32-bit bus market but that Multibus II will not be far behind for long. Hughes expects 50 or 60 more manufacturers to announce Multibus II board products this year.

Some expect Intel to parlay the proliferation of Multibus I products into sales for Multibus II. For one, Intel's Hanson anticipates that Multibus I board manufacturers will upgrade their product lines to 32-bit microprocessors and Multibus II. He also expects benefits from Multibus I's name recognition. But Hughes thinks that the popularity of Multibus I may not provide such ready acceptance of Multibus II. "Some Multibus I customers will upgrade but most of the prospects are coming from the mainframe arena," says Hughes. "Multibus II is getting a lot more sophisticated customers." ☐

VMEbus products expecting 66% compound annual growth

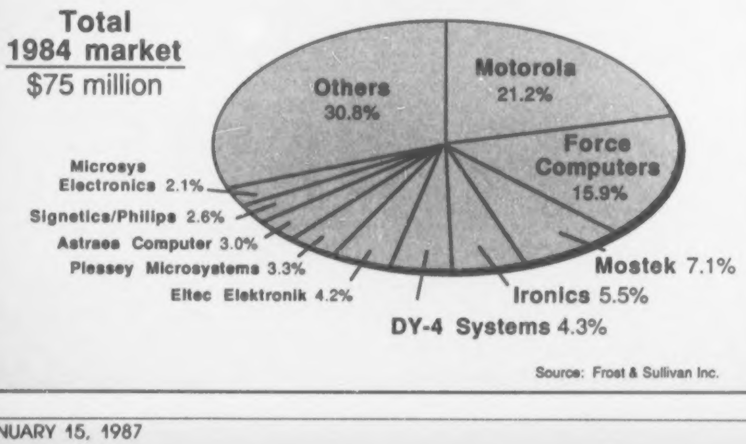
($ millions)



Source: Frost & Sullivan Inc.

Top 10 VMEbus suppliers control 70% of the 1984 market

Share of market by company



Source: Frost & Sullivan Inc.

MILITARY ELECTRONICS

Defense contractors defend a market

The heyday of ever-increasing defense dollars is over, but smart military contractors still find competitive opportunities

By John Kerr

Military contractors that think the worst of the defense-budget squeeze is over are wrong. Funding for defense is expected to shrink and will continue to put the clamps on programs big and small. Moreover, the contraction will persist until the end of the decade, to be followed by a miserly upturn in the mid-1990s.

"We can't see Congress allowing the Defense Department 4% growth when the economy is only going to be growing at 2% to 3% annually," explains Don Weaver, chairman of the ten-year forecast subcommittee for the Electronic Industries Association's (EIA) government division.

Weaver's group predicts that Congress will tighten the total defense budget tourniquet from fiscal 1987's budget authority of around $283 billion to $272 billion by 1990, easing off to let funding reach $284 billion by 1996, not including inflation.

But don't break out the collection box for defense-electronics contractors yet. While the EIA foresees a near-term drop in electronics content of the Department of Defense's (DoD) budget, from $53.5 billion in fiscal 1987 to $52.4 billion in 1989 in procurement; research, development, test and evaluation (RDT&E), and operations and maintenance (O&M) sector will jazz up the decade-long defense dormancy and reach $58 billion in 1996.

In part, this is because demand will continue throughout for computer, infrared, electro-optics, and laser technologies, intelligence-gathering equipment, electronic-warfare (EW) programmable jammers and millimeter-wave hardware.

But, it is also because some sectors seem immune to budget cuts. While contractors solely reliant on new missile and aircraft business will still feel the pinch, those supplying electronics systems and components to space programs are in a strong position.

Similarly, those gearing for improvement programs and upgrades or aligning themselves as second sources, are doing themselves big favors. The conclusion: while there is little to rejoice over in grandiose big-ticket strategic business, there is plenty of work in between, in humbler more conventional warfare programs.

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While there is little to rejoice over in grandiose big-ticket strategic business, there is plenty of work in humbler more conventional programs

The EIA's overall $283 billion defense figure is middle of the road. Less gloomy is Hewlett-Packard Co. cofounder David Packard, chairman of the President's Commission on Defense Management, who forecasts 1.5% real growth in coming years. He says that Defense secretary "Caspar Weinberger is talking about 3% real growth; I don't think Congress will support that level of growth."

Others believe even the EIA's numbers are sugar coated. "Things are not going to get better — they're going to get worse. The 1988 budget could be down $25 billion in 1987," warns Robert Walters, deputy director for the national security committee on the budget at the House of Representatives.

Whichever prognosis, contractors feel ill already. Researchers tell them that new programs will be rare, and program stretch-outs, delays and recompetition will be the order of the day.

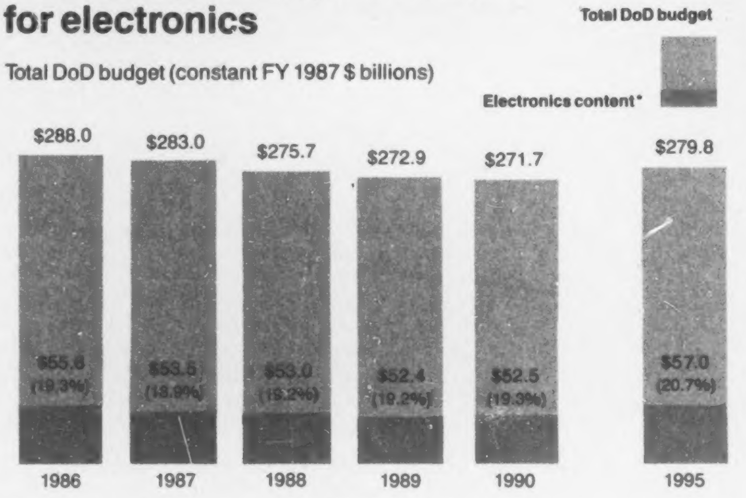
The big losers will be shipbuilders and missile and aircraft manufacturers, as procurement contracts mature without many to replace them. Congressional diktat says the 1980s hardware-buying binge — from 1982 to 1986 procurement outlays amounted to $344 billion, up 56% on the previous five years — just cannot be sustained.

The same goes for RDT&E programs: contractors can expect fewer new starts. Even President Reagan's darling, the Strategic Defense Initiative (SDI), or "Star Wars" program, will not see full-scale engineering development before 1996. "It won't be as easy as it was during the gravy days of the [anti-] Soviet build-up," cautions Weaver.

The military paradox

Paradoxically, defense contractors have more new business opportunities than ever, despite declining budgets. The prime reason is recompetition: one contractor's poison becomes another's meal as programs are spread

Defense spending: $54 billion for electronics



*Electronics content includes procurement, RDT&E and O&M

Source: Electronic Industries Association

out between two or among more suppliers. The winners are those that anticipate what is up for grabs: "The real problem is betting on the right horses," says James Lee, corporate manager for market analysis at Hughes Aircraft Co.

News of a downturn comes as no surprise to alert contractors. Cutbacks are the inevitable fallout from years of defense overspending, and must be seen in perspective: defense budgets, though deflating some, are still airy enough to float above the historic trendline dating from 1960, and will remain so because no politician these days wants to hamstring defense to the point where the country is imperiled.

Law makers, however, are happy to hound a military-industrial complex that they believe has not given the taxpayer the best deal. There is a strong political tail wind following the defense-reform proposals of the Packard Commission. And the mood is for streamlined acquisition procedures, better auditing and more use of commercial products.

The military is getting the message; it already appears that there is no such thing as a cozy sole-source contract anymore. According to the EIA, 50% of all prime U.S. contracts are now bid competitively versus 33% only two years ago.

Even the prime contractors are beginning to insist on jousting among their subcontractors. Just as the military services industry has appointed "competition advocates" to ensure that dual-sourcing is the order of the day, so major corporations such as Boeing Co., General Dynamics Corp. and General Electric Co. are setting up their own advocacy departments.

Defense contractors are also being encouraged to cut costs by shopping abroad for nondevelopmental items — systems already developed elsewhere — and by teaming with foreign firms to develop new hardware.

The military's use of commercially available off-the-shelf products draws mixed reviews. Many claim this practice is in full swing, a good example being the $2 billion worth of standard 32-bit desktop computers the Army wants for command and control duties. Others hold that it is impossible to sway long-held military-specification beliefs: "You could offer [the military] the war-winning weapon and they wouldn't buy it because it isn't MilSpec. I'd say good luck," retorts Wolfgang Demisch, an analyst with First Boston Corp. on Wall Street.

The new era of defense contracting is pushing some players toward the critical mass they feel that they need to compete. Wall Street pundits like Edmund Greenslet of Merrill Lynch, Pierce, Fenner & Smith have predicted industry consolidation for years, and 1986 looked like the year it began to roll.

Early in the year, General Electric bought out RCA Corp. in one of the biggest buys the electronics industry had ever seen. In mid-1986, Loral Corp. made a play for Sanders Associates Inc., but was outbid by the mighty Lockheed Corp. And in late fall, Emerson Electric Co. agreed to buy Hazeltine Corp. for about $189 million. Further buys are expected: Ford Motor Co., stung by losing Hughes to General Motors Corp. in 1985, is keen to compensate, possibly with an attractive defense-electronics bargain of its own. And Goodyear Corp., now restructuring, may be seeking other aerospace action.

> The mood is for streamlined acquisition procedures, better auditing and more use of commercial products

One alarming trend is the increase in dollar value of "black," or classified programs. First Boston's Demisch puts this "spreading blackness," as he calls it, as high as a third of all RDT&E work and possibly 20% of procurement.

It is an undercurrent that few are pleased with. Says Demisch: "Expansion of black programs reduces the public's understanding of the business and, consequently, is a significant negative across the board." Defense-electronics executives say that this is evidence of growing distrust between the Pentagon and the contractors, and they describe the trend as disturbing. Not only does it make communications more difficult, but it slows potential negotiations and adds inefficiency to the contracting process, which is good news for no one.

Good news is what contractors, dependent on major missile procurement programs, would prefer right now. The EIA predicts that procurement funding for this sector will fall from this year's $6.1 billion to $5.4 billion by 1996 as strategic programs like the land-based M-X intercontinental ballistic missile made by Martin Marietta Corp. and the submarine-launched Trident primed by Lockheed reach completion.

Program stretch-outs and delays will be the norm; the dramatic reductions in nuclear stockpiles discussed during the Reagan/Gorbachev talks in Iceland, although welcomed by most people, are less hearty news for the missile makers. One bright spot on the strategic front: Trident is a key candidate for being re-competed.

Steep drop-offs of big-ticket strategic missile production funds will tend to mask the slower slide in cash available for building tactical missiles like Hughes' Advanced Medium Range Air-to-Air Missile (AMRAAM) and the Stinger AAM.

Meanwhile, contractors on both

major procurement and development programs for the Navy can hardly avoid that sinking feeling. With the 600-ship fleet essentially completed or under contract, all that remains is equipment modernization and sporadic replacement of a few older vessels.

However, the Navy is throwing out life buoys galore — for those electronics suppliers diligent enough to spot them. Because of Soviet submarine advances, the United States is keen to enhance its antisubmarine warfare (ASW) capability. "We suggest you stay close to this one," EIA panel members told listeners at a recent defense-electronics symposium.

Navy cheerleaders for R&D on ASW were looking for $2 billion this year — twice that allocated in 1981. Advanced sonar for submarine surveillance will provide plenty of good opportunities in areas like sensor technology, multisensor fusion, fiber optics and artificial intelligence.

Additionally, mine warfare could present R&D openings. And the Navy may adopt a Local Area Anti-Air Warfare System (LAAAWS) to protect U.S. and NATO ships in a fiscal-1988 program start that could form the kernel of a "Naval Defense Initiative."

When it comes to aircraft, both procurement and development programs are up in the air. While late-1980s peaking and subsequent fall of spending on key elements like Rockwell International Corp.'s B-1 bomber distort budget figures downwards, activity in other areas keeps electronics subcontractors guessing.

The LHX, a proposed light attack helicopter, is something of a sacred cow with its sponsor, the Army. Should it receive approval, electronics suppliers can get out the champagne: two-thirds of the helicopter's value is in electronics.

On the fighter front, the Air Force propels its Advanced Tactical Fighter one stage forward by choosing Northrop Corp. and Lockheed as the two design finalists. Design is one thing, and production another, however; the Congressional jury is still out on whether it should upgrade existing aircraft, such as the F-16 with standoff weapons.

Generic defense

Guessing games aside, there are generic advances that will benefit electronics vendors. Be it for strategic or tactical theaters, the Air Force wants parts and systems with lower weight, lower power consumption, less heat dissipation and higher speed — the amalgam of "impossibles" normally twined with demand for lower cost. Electronics contractors offering systems that incorporate very high speed integrated circuits and self-testing features will be smiled upon.

Additionally, in B-1 and B-52 bomber upgrades, the Air Force wants to decrease operational costs by installing equipment with mean times between failures as high as 3,000 hours — up to 14 times today's norm.

Operation fightback: Countering terrorism with technology

There is a new war going on these days. With nuclear showdown on hold and conventional warfare in check, terrorism is the misanthropic militancy of the late 20th century.

So far, this "New War" has not cursed the United States. But studies suggest that this is an uneasy tranquillity at best, and that extremist violence is escalating. The Rand Corp., a think-tank in Santa Monica, Calif., says that the number of incidents worldwide has been rising 12% to 15% yearly.

This calls for retaliatory tactics which traditional peacekeeping forces have not yet mastered. It also challenges electronics vendors to devise equipment that helps combat terrorism.

Technology has already been critical to some celebrated successes against extremists. When Britain's Special Air Service (SAS) team stormed the Iranian Embassy in London in 1980, they put electronic eavesdropping equipment down chimneys and against walls to pinpoint the location of the gunmen. In 1977, Dutch Marines relied on advanced heat sensors and night-vision goggles to locate terrorists holding hostages aboard a train.

America's special-operations forces (SOFs) — including the Army's Green Berets, the Navy Seals and the Pentagon's super-secret Delta Force — have not shared comparable triumphs. Concern that America is far from ready for the New War is prompting legislation that may reorganize the way these counterinsurgency units are run.

The U.S. Senate's proposal — reckoned to have the best chance of becoming law — envisages a unified command structure reporting to the DoD. "Our goal will be for [special force] funding to be increased substantially," says an aide to Senator William Cohen, (R-Maine), the initiator of the Senate's plan.

That, says the EIA, makes special operations a sector worth watching. The trade group reports that SOFs budgets totaled $1.2 billion in fiscal 1986 and should reach $1.7 billion this year.

Proponents of higher funding maintain that SOFs is 0.005% of the defense budget, hardly commensurate with the seriousness of terrorism today. The EIA adds that much of the $1.7 billion will go to airlift planes and almost nothing to RDT&E, and the association predicts that over the next five years SOFs will get $7.5 billion.

Assuming an electronics content below the typical 20%, it could still yield $1 billion in business for electronics vendors, supplying equipment like: standardized avionics; three-dimensional night-vision goggles; global-positioning satellite receivers; command posts; and secure communications equipment.

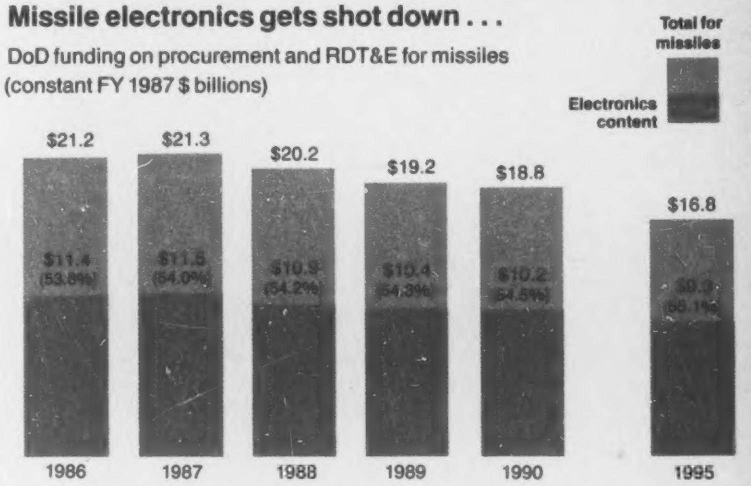
Other technologies may be of benefit too: smaller closed-circuit TV cameras that work in the dark; optical disk systems to call up databases on known radicals; ballistic computers to give snipers unerring aim; sensors smart enough to tell a stray dog from an armed intruder.

Many remain skeptical that extra SOFs funding will materialize during tight budget constraints and while terrorism is not perceived as a national threat. One equipment maker cites the difficulty another U.S. force, the Coast Guard, has in getting funds to counter drug smuggling. Another makes a telling aside: "Nobody ever got above brigadier with Special Forces."

Moreover, technology alone cannot permanently roll back the New War. "Unfortunately, there's no magic button you can press to stop all terrorists," says one vendor. ☐

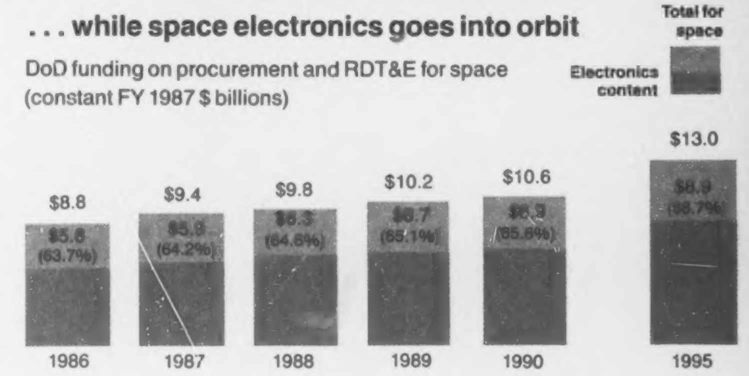
Missile electronics gets shot down . . .

DoD funding on procurement and RDT&E for missiles (constant FY 1987 $ billions)



. . . while space electronics goes into orbit

DoD funding on procurement and RDT&E for space (constant FY 1987 $ billions)



Source: Electronic Industries Association

Suppliers matching those levels are ahead of the game.

Many vendors will be betting on mainstream electronics growth areas like integrated battle management and command, control and communications (C^3). C^3 funding of over $24 billion was requested for fiscal 1987, double the 1982 amount. Among the more interesting — though volatile — program possibilities are the Midgetman small intercontinental ballistic missile C^3 package and the Worldwide Airborne Command Post, both for the Air Force.

And there is often-overlooked business in computer security and management information systems for the Pentagon and related agencies: up to $16 billion worth, according to the EIA.

Space dollars

But the sector that remains robust like nothing else is space electronics. Thanks largely to growth in procurement of communications and reconnaissance satellites, military acquisition of expendable launch vehicles and the Military Strategic Tactical and Relay (MILSTAR) satellite, procurement funding here will soar from $2.6 billion this year to $4.8 billion in 1996. Similarly, RDT&E space-electronics monies will expand from $3.3 billion to $4.5 billion in the same period, fueled by ongoing research on C^3 and by SDI concept work.

Interestingly, SDI has lost some of its shine in the past year. Although there is now a vocal lobby campaigning to implement a diluted version soon, rather than waiting forever for its completion, opponents of the mega-research program have had considerable say of late.

Fiscal 1987 funds for Star Wars came in just over $3.5 billion, up 17% from last year, but about 30% less than the President's request. Consensus is that SDI is here to stay; with 1,000-plus contracts awarded so far, it has acquired a momentum all its own. "We don't see it being terminated — even under a democratic administration," remarks Nathan Higginbotham, manager of government programs at McDonnell Douglas Corp.

The program is being reshaped, however. Directed-energy weapons — the "ray gun" systems that SDI is notorious for — may lose backing in favor of areas like battle management and C^3. And SDI itself may lose out to more popular alternatives.

Indeed, law makers on Capitol Hill have gotten more excited about two other defense initiatives: ADI and especially CDI. ADI — Air Defense Initiative — is intended to guard against the threat to U.S. airspace from Soviet bombers just as SDI is meant to protect it from Russian missiles. The program is considered a very high risk, but could quickly amass backing for proposed R&D funding of $606 million from 1987 to 1991.

But the Conventional Defense Initiative (CDI) is what has Congress jumping. "It swept [Capitol] Hill like wildfire," says Hughes' James Lee. CDI began as a proposal by the House Armed Services Committee (HASC) that sought to redress the R&D balance and move it away from strategic warfare and toward tactical warfare.

The $462 million proposed for fiscal 1987 by HASC — the authorized total came in well under that — is coming out of SDI's hide and would fund an array of tactical defenses intended to have as much visibility as SDI, but for a fraction of the cost. Technologies would include: smart air-launched standoff munitions; smart mines — both land and ocean; and hypervelocity missiles for ground combat.

Meanwhile, there are hosts of advanced-technology programs for defense-electronics companies to address. Today the talk is of "brilliant" weapons, systems whose intelligence merits more than the term "smart." Opportunities will likely open up in infrared focal-plane array producibility; microwave/millimeter wave monolithic integrated circuits; optical switching; and "vetronics" — vehicle electronics, that would lead to robot tanks and other unmanned vehicles.

In one critical area — manufacturing productivity — attention is wandering. Despite the promise of gains in both quality and production cost on all sorts of defense systems, manufacturing technology programs appear to be on the backburner. One theory is that no military top brass earned medals rooting for projects viewed more as penny-pinching pedantry than political pennants. "It's like the kiss of death," says one electronics contractor. □

Marching to the beat of foreign drummers

America once called the shots in military electronics deals overseas. But now, here comes Europe and Japan

By John Kerr

Gone are the days when U.S. defense electronics contractors rode carefree atop America's mighty military juggernaut. Today they risk being pushed off by aggressive overseas contestants.

They risk rebuff abroad too. In Western Europe, many American defense firms are experiencing cuts in sales. In the Third World, they are steadily losing to European protagonists.

American incompetence is not the cause. Put it down instead to "internationalization" of the arms trade. "Everybody is demanding a piece of the action these days," says Bernard Schwartz, chairman of New York City-based electronic-warfare (EW) specialist Loral Corp.

The action is accelerating as military-equipment sales crisscross the globe in an ever more intricate web, and as contractors from many nations team up to tackle today's complex weapons programs. The industry's new globalism is apparent in efforts by Japanese vendors to capture a larger portion of the military electronics market. It surfaces in the Pentagon's desire for Japanese technology. It appears in new participation of nations not renowned for their military-equipment might, like Canada and Brazil. And it is evident as European firms jointly bid with U.S. partners on prestigious programs on both sides of the Atlantic.

In Europe especially, America is seeing a dwindling dominance in defense equipment. Many there have long complained that arms trade has been a one-way street — in America's favor. Independent analysis bears them out: the trade journal *Military Logistics Forum* reports that the 1970s saw the United States exporting roughly nine times the value of defense equipment to other North Atlantic Treaty Organization (NATO) countries as it imported. And the trans-Atlantic trade picture is changing fast. By 1985, claims *Military Logistics Forum*, the export/import ratio had dropped to three to one. The U.S. Arms Control and Disarmament Agency confirms that U.S. arms exports are falling after a long period of growth: from $11.8 billion in 1983 to $9.4 billion last year.

Today's multinational military market is as much the product of improving capability among foreign contractors as it is of encouragement by the Congress of competition in procurement, which opens U.S. military programs to overseas suppliers. And political expediency plays a plumlike role. With Congress pushing the armed forces to buy more "nondevelopmental items" — systems already developed elsewhere — Britain is hoping it can sell its Rapier mobile antiaircraft missile system to the U.S. Army as a replacement for the failed Sgt. York Divisional Air Defense (DIVAD) weapon. There are also European hopes of supplying trainer aircraft to U.S. forces.

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America is seeing a dwindling dominance in defense equipment

European expertise, eroded by the ravages of World War II, has bounced back with a vengeance. "Ten to 20 years ago, the U.S. was clearly the leader in defense technology in the Free World. The European defense industry since then has caught up and in some instances is ahead on delivery schedules, pricing and technology," says James Lenehan, Rockwell International Corp.'s director of foreign trade policy.

Predictions are that this capability will only improve. With designs for several new all-European-made fighter jets already in the planning stage, Europe may be building up to 4,000 of its own fighters by the mid-1990s. National-defense markets in countries like West Germany and Italy are much too small to warrant homegrown arms supply. But under the umbrella of the European Economic Community (EEC) — the "united states of Europe" — coproduction ventures like the Tornado warplane become viable. "They're going to have an economy of scale that will make them very, very powerful," adds Lenehan.

Europe's new-found domestic strengths, backed by an overt Euro-chauvinism, make it harder for U.S. firms to export there. "It's difficult to sell directly into countries that have capabilities of their own," says John Dixon, chief executive of E-Systems Inc., a Dallas electronic warfare company.

Like others, E-Systems has seen its overseas sales dented. Palo Alto, California-based Watkins-Johnson Co., whose defense products include test equipment, experienced a downward step in 1985 exports to $42.9 million — 18% of total sales — from $46.3 million, or 22% of total revenue, in 1984. Even Loral, which has boosted the dollar value of its exports to a quarter of its backlog, concedes that it is no picnic: "There's no question that the sales are harder than they were," says chairman Schwartz.

But, some Euro-observers feel that

European firms are hardly on easy street when in comes to selling into the States. "The two-way street has turned out not to operate. It's extremely difficult for British companies to sell into the United States," remarks Miles Saltiel, a financial analyst with Prudential-Bache Securities Inc. in London.

The American dream

British electronics giants The Plessey Company Plc. and Racal Electronics Plc. are trying to prove him wrong. "The American market *has* to be my No. 1 market," says Michael Whiteman, managing director of division Plessey Avionics, which is teamed with Boeing Aerospace Co. to compete for a replacement for Britain's Nimrod airborne early-warning (AEW) system. Whiteman's $75 million operation has grown sales to the United States from $5 million at its inception three years ago to $10 million now, and it is stepping up the pace with new consultancy agreements in Washington D.C., and on the West Coast.

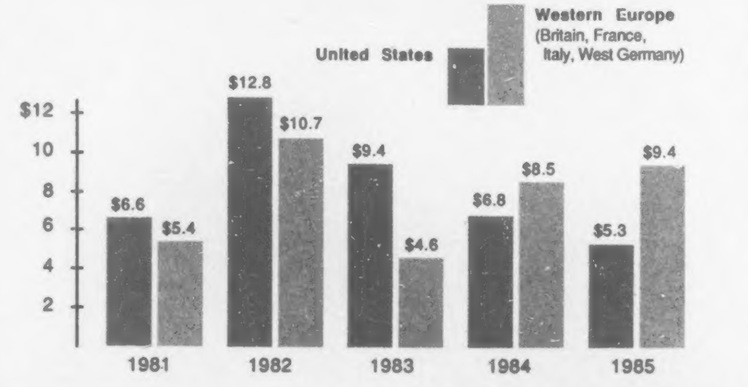
Others, like Racal, are acquiring American accents. Racal-Dana Instruments Inc. was formed in 1977 when Racal took over Dana Laboratories in California and today builds about 80% of what it supplies to U.S. forces there. Explains Brian Hull, vice president of marketing: "We feel it's important not only to have a domestic presence but to have [local] engineering content."

LORAL's SCHWARTZ: "There's no question that sales [of military exports] are harder than they were"

Hull's company has just beaten Hewlett-Packard Co. and others to clinch a $10 million-plus order from Kelly Air Force Base for universal counters, and expects to double 1986 bookings to $20 million. Racal is not the only European supplier to set up shop here: the Marconi group of Britain's General Electric Company Plc. (no relation to GE in the States) has a factory in Atlanta producing "head-up displays" for jet fighter pilots and another U.S. plant building automated test equipment for the military.

The U.S. is losing Third World arms business to Western Europe

Arms transfer agreements with the Third World by major supplier (current $ billions)



Source: Congressional Research Service

But many believe it will be tough to ignore mounting nationalism in the States and even harder to beat an entrenched "buy-here" mentality that despite Congressional urging to source already-developed equipment from abroad, means the two-way street still has a noticeably unidirectional flow. "There still is a very strict bias with government to buy American," says Philip Friedman, an analyst with Wall Street investment brokers Drexel Burnham Lambert Inc.

To counter growing nationalism on both sides, the answer for American and foreign companies alike lies in collaboration, or "teaming." "Arms cooperation is the name of the game — finally," says Dr. Charles M. Perry, a senior analyst with the Institute for Foreign Policy Analysis Inc., a Cambridge, Mass., think tank. Foreign players get guidance from U.S. partners in circumnavigating the bureaucratic maze, and vice versa. Pockets of expertise across the globe can link up to tackle defense programs with worldwide application. And all of them can share the costs — and risks — as weapons programs grow in complexity.

Teamwork

Teaming is nothing new, and examples are myriad: McDonnell Douglas Corp. builds the Marine Corps' AV-8B version of British Aerospace Plc.'s Harrier "jump-jet." Racal and GE's RCA Corp. have long shared radiocommunications work. And recently, France's Thomson SA and America's GTE Corp. jointly won the $4.3 billion Mobile Subscriber Equipment (MSE) contract for battlefield cellular telephones from the U.S. Army.

Elsewhere, teaming is also teeming. Rockwell is hand-in-glove with Marconi on the Navy's High-Frequency Anti-Jam (HFAJ) communications program. GE and Germany's Siemens AG are jointly developing a new artillery surveillance radar system for the West German army. The U.S., Great Britain and West Germany have signed a memorandum of understanding for coproduction of Hughes Aircraft Co.'s Advanced Medium-Range Air-to-Air Missile (AMRAAM) and Europe's own ASRAAM short-range missile. And an international consortium developed the Multiple-Launch Rocket System (MLRS).

The Pentagon prompted RSI — rationalization, standardization and interoperability — in the early 1980s, but with little effect. Later, a NATO Armaments Cooperation steering group was formed at the Department of Defense. But it took horror tales of $600 toilet seats to put fire under those responsible for defense procurement.

Now Congress is pushing the process into research and development (R&D) too. An amendment to the fiscal 1986 defense bill by Senator Samuel Nunn (D-Ga.) allocates $250 million to spark cooperative R&D projects with European companies. Already some have kicked off: there is joint work on a NATO "identify friend or foe" system; a modular stand-off weapon; a precision guided munitions project; a software support program, and several others. However, many contractors are still waiting to see how well teaming really works. Two significant bellwethers are the GTE/Thomson MSE program, and the Boeing/Plessey AEW bid, if it wins.

Heavens above

Meanwhile, President Reagan hopes his Strategic Defense Initiative (SDI), or "Star Wars" program, becomes the very model of global cooperation. Argument rages over how much the Allies should participate: all in favor say aye, largely because it is politically expedient to include nations that might otherwise harp about the drawbacks of the multibillion dollar program. The nay-sayers point out the folly of handing foreigners the technology — with the cash to exploit it. Gripes one critic: "It's a free lunch. They get the U.S. taxpayer to pay for advanced research."

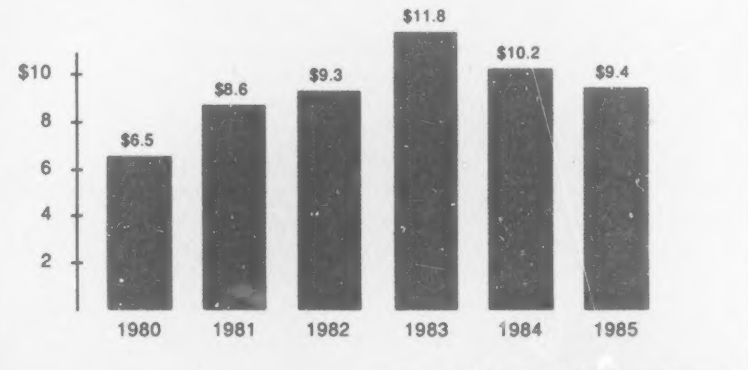
Europe insists that an all-American SDI would corrode the spirit of NATO and put giant potholes down one side of any two-way arms-sales street. So far, though, 'ayes" outweigh "nays": during fiscal 1987 budget battles, Congress voted down an amendment by Senator John Glenn (D-Ohio) which would have limited participation by the Allies.

Not a lot has gone overseas yet: for fiscal 1986, the SDI Office says that under $20 million of the $2.7 billion allocated to "Star Wars" — less than 1% — went to foreign research. Recipients included Britain's Ferranti Plc. and Heriot-Watt University, which between them obtained $285,000 for optical-computing studies.

During fiscal 1987, when $3.2 billion has been authorized for SDI, some larger overseas contracts will start rolling: Israeli organizations alone have been granted some $5 million for multiyear computer architecture studies. However, it will be a year or two before the overseas portion expands much in percentage terms.

Enter Japan

SDI is providing the invitation that could admit one especially coy nation to the global defense-technology club: Japan. In mid-1986, Prime Minister Yasuhiro Nakasone inked a declaration of intent to consult with the United States on SDI. The U.S. hope is that Japan will formally sign up soon and thus begin contributing in essential research areas like gallium-arsenide semiconductors and electro-optics.



America's defense exports: Sounding the retreat

Value of U.S. military exports (current $ billions)

Source: U.S. Arms Control & Dis...mament Agency

Traditionally, Japan's defense budget has been minimal and its population, with World War II deep in the national subconscious, reluctant to build a showy arsenal of its own, much less sell arms abroad. Political encouragement — notably from Washington — is urging that Nakasone's government get out from under America's defense umbrella. The unspoken message is: put some of the funding you so willingly use for technological one-upmanship into military self-reliance.

Few U.S. defense contractors feel it is worthwhile trying to market in Japan; fewer believe that will change. America's frustration with Japan's trading tactics surfaces readily. Argues Christopher Demisch, a Wall Street analyst with First Boston Corp.: "The Japanese distinguish themselves by buying as little military hardware as possible. They have a $50 billion annual trade deficit, and they don't buy. And we're stupid enough to sell [the technology] to them."

Instead, Japan builds for its tiny armed services under license: McDonnell Douglas' F-15 is made there; so are Loral's ALR-56 radar warning receiver for the F-15, and Lear Siegler's automatic flight control system for the P-3C aircraft.

U.S. officials cringe at what seem to be deplorable economies of scale. Says Rockwell's foreign-trade policy chief Lenehan: "When you transfer technology, you can't build these things anywhere near as efficiently as the guy making them in four figures. They would get more clout for their yen if they bought from the U.S., plus they'd reduce their terrible trade balance. I think they're insisting on it so they can learn the technology so that 10 years from now they can be a producer."

If that is so, it may be a case of who gets what out of whom first. The Pentagon covets Japanese technology, and under a 1983 Washington-Tokyo agreement, has helped set up a joint military-technology commission to facilitate technology transfer, mostly to the States. The agreement provides a framework for both governments to encourage private industry to initiate technology exchanges. So far, though, results have been poor.

The developing world

Beyond NATO, Japan, Australasia and the Warsaw Pact nations, that leaves only the Third World as a market. And there, if some observers are to be believed, U.S. contractors are on

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Sending CAD tapes to photoshops an unnecessary step, PCB maker claims

To move CAD designs more quickly into production, and produce higher-quality fine-line double-sided and multilayer SMOBC boards, Velie Circuits' state-of-the-art equipment adapts to customer mag tapes

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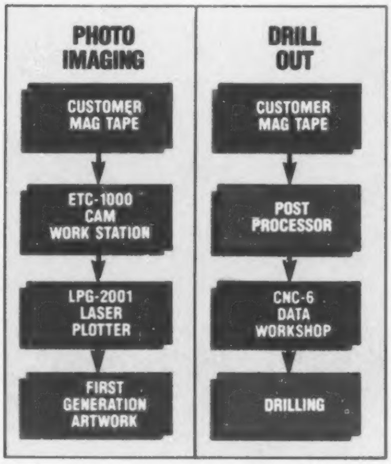

Steps to generate artwork and drill-out directly from customer mag tapes.

Data for drill-out, on the other hand, is directed through a post processor into a CNC-6 Data Workshop which establishes formats and sets drill functions for optimum hole location accuracy.

Quality is further enhanced by a new Orbot PC-1031 to check line widths and spacing to less than one mil resolution. Thus, the quality of impedance control boards is ensured by controlling line widths over the full length of the trace.

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JAPANESE PRIME MINISTER NAKASONE has put his signature on an agreement declaring his country's intent to consult with the U.S. on Star Wars

Reuters/Bettmann Newsphotos

business. The Third World doesn't have any money. They want an arm and a leg, and they want you to pay them for buying it *and* set up an industry for them to boot. This is a business where the profitability is very low in the long term," maintains First Boston's Demisch.

Indeed, arms deals with the Third World are on the decline, and the U.S. share along with it, according to the Congressional Research Service at the Library of Congress. The value of U.S. arms transfer agreements dropped to $5.3 billion in 1985 from $9.4 billion in 1983, in current-year dollars.

One reason for the drop-off: those pesky Europeans going international again. Britain, France, Italy and West Germany traditionally have had strong arms exports to developing nations. Great Britain boosted its share of all Third World arms agreements to 21.8% in 1985, from 1.6% the year before, largely because of a multibillion dollar aircraft contract with Saudi Arabia. The trendline of major European nations' Third World arms contracts is steadily up; the U.S.'s is spiraling downward.

Partly it *is* because less-developed nations have limited money; partly it is because security-assistance funds from the States have been plunging. But, it is also the product of growing arms-production capability in nations like Brazil and Israel — and of stiffer insistence by many countries on tough offset agreements, whereby the purchasing nation demands participation in production or by trade reciprocity, if it has goods to offer in return. A good example is the oil which British Aerospace once had to take for sales of the Tornado fighter it helps build.

According to Patrick M. Hall, vice president in charge of Rockwell's internal trading house for dealing with offsets and counter-trade, offset contracts are on the rise. "Five years ago, there was hardly any to speak of," he says. Hall has felt the brunt of new offset-negotiating skills in Korea and Greece. As often as not, emerging nations like these have learned the offset game from tough First-World experts like Australia and Canada.

Before buying United Technologies Inc.'s Sikorsky helicopters for its navy, Australia demanded to build the machine and to write much of the computer software for the craft. Holland is another nifty negotiator: The trading-house run by Rockwell's Patrick Hall buys Dutch-made electronics parts for several Rockwell groups as part-payment for submarine communications gear for the Dutch navy.

And on Raytheon Co.'s Patriot air-defense missile, Holland demands nearly 100% offset with "in-program" deals that see parts of the system built in Holland, and "out-program" pacts, where America's Defense Department sources Dutch electronics equipment for various applications.

Britain too is showing Falklands grit in negotiations with Boeing on the Nimrod airborne early-warning system, which originally called for 100% offset. But the Westminster government, plagued by unemployment issues, forced Boeing's arm up to 130% offset, meaning that Boeing will give more than it gets. The agreement now calls for British firms to get AEW work that employs up to 8,000 a year, plus future contributions through Boeing to U.S. programs in everything from fiber optics to data links.

Crisscross trading arrangements like these give U.S. contractors logistics headaches. "It's a continuous problem for them to find offsets. People feel they're getting the short end of the stick, and they'd rather be doing something else," argues Demisch.

But when Asian Pacific defense markets like Korea are hot and U.S. markets are not, and when big programs like the British AEW come along, there's often not much else to do. Offsets, admit hard-pressed U.S. defense contractors, are simply the price of staying in what is very much an international game these days. ☐

Silicon Glen tunes in on just-in-time

The Scottish Development Agency is using JIT delivery to lure manufacturers and improve their supplier pipeline

By Bruce C.P. Rayner

The Scottish Development Agency (SDA), which has a major directive to attract foreign investment, is counting on a vast just-in-time delivery project to provide a competitive advantage. An additional advantage is required as the worldwide electronics slump has curtailed industry expansion at the same time more nationally and regionally sponsored agencies are offering equal packages of market proximity, skilled workforces and tax advantages.

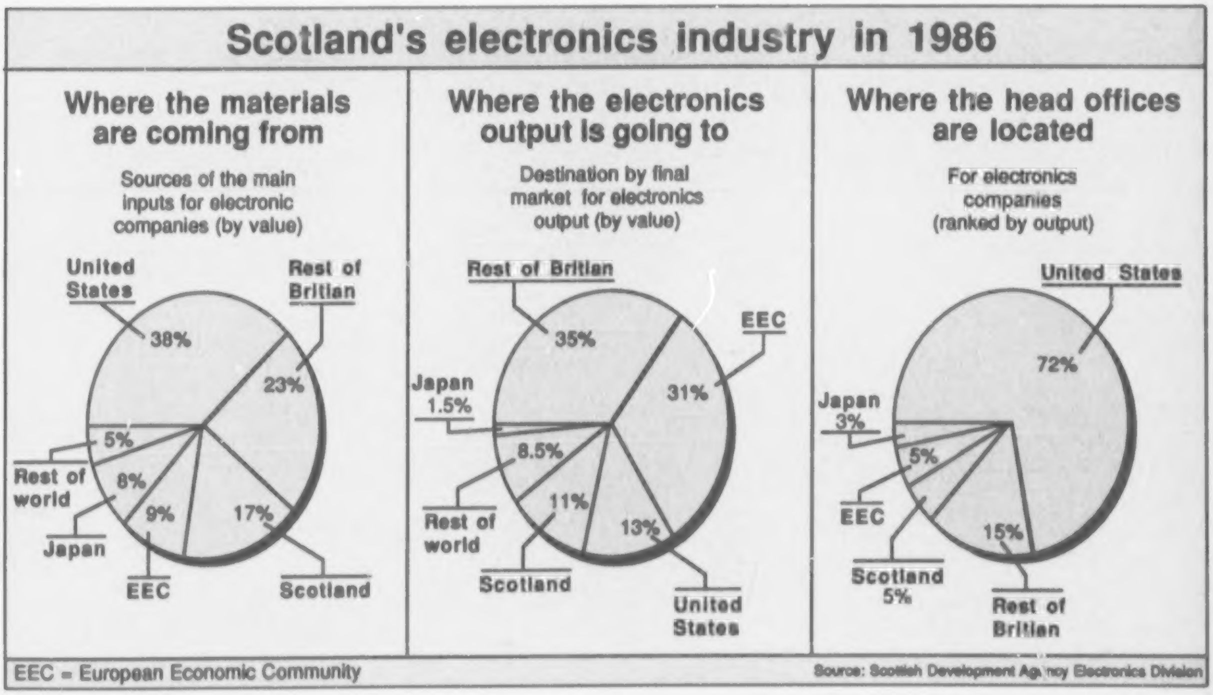
Many of the world-class electronics players are located in Scotland's central belt dubbed Silicon Glen — Burroughs, DEC, Ferranti, Hewlett-Packard, Honeywell, IBM, Motorola, NCR, NEC and Wang to name a few — and the SDA is always trying to attract more. The SDA officials hope to use Japan's just-in-time manufacturing system's (JIT) philosophy and tailored it to suit Scotland. JIT has two components: intrafirm JIT, to improve productivity and efficiency *within* the firm; and interfirm JIT, or JIT sourcing, to strenghten relationships *between* a manufacturer and supplier. SDA officials hope that if Silicon Glen embraces JIT, the area will continue to attract foreign investment.

By accident or design, Silicon Glen represents an almost unique agglomeration of electronics firms. It has the highest concentration of electronics companies in all of Europe and is similar in some respects, but on a smaller scale, to both the high-tech highway of Route 128 around Boston and the Silicon Valley region south of San Francisco.

Industry concentration provides certain economies, but there are additional advantages that can be reaped through corporate cooperation. If the high-tech community can be encouraged to cooperate to smooth production — both upstream with customers and downstream with suppliers — substantial savings can be derived from the close proximity, and sales can go to Scottish suppliers rather than foreign sources.

The savings attributed to JIT come from coordination of production runs, closer communication, tighter delivery windows and lower transportation costs. Quite simply, just-in-time sourcing — delivering the right quantity and quality of product just where and when your customer needs it — is essential to Scotland's continued success in the European electronics marketplace.

The pressure to smooth supply



Scotland's electronics industry in 1986

Where the materials are coming from

Sources of the main inputs for electronic companies (by value)

Where the electronics output is going to

Destination by final market for electronics output (by value)

Where the head offices are located

For electronics companies (ranked by output)

EEC = European Economic Community

Source: Scottish Development Agency Electronics Division channels is coming mainly from the onshore Japanese and American electronics manufacturers that have already adopted JIT internally. Many of them flatly refuse to source locally if the supplier does not adopt JIT. As the SDA reports, only about 12% of the industry's incoming supplies are sourced in Scotland, although most of the supplies are locally available. Seventy percent of U.S. and Japanese companies located in Scotland purchase 25% or more of their materials and components from their home countries.

At the same time, Pittiglio, Rabin, Todd and McGrath (PRTM), the international high-tech consulting firm that works with the SDA, claims that over the past four years, many manufacturers have reduced their supplier base by up to 80%, contributing further to the reduction of Scottish sourcing. One international company located in Scotland has reduced its suppliers from 1,000 down to 200 while another has dropped from 450 to 280, PRTM claims.

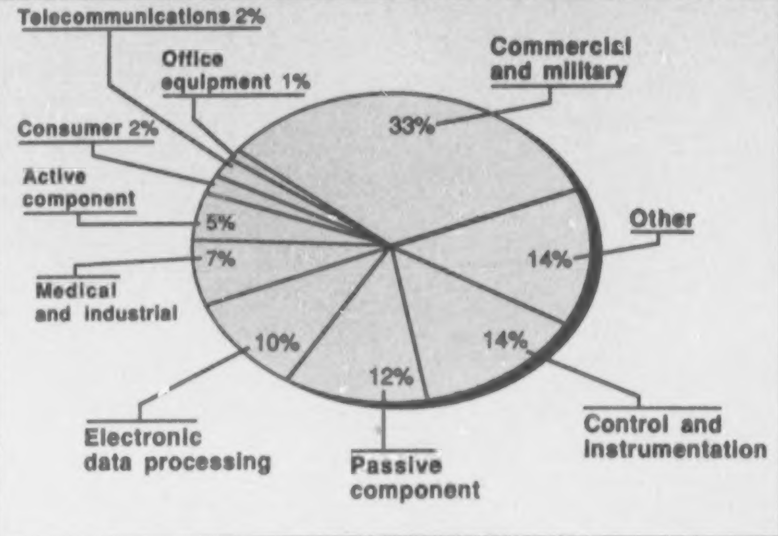
In cooperation with electronics manufacturers, the SDA hopes to reverse this trend by championing the JIT sourcing cause. Jeffrey Berg, one of three PRTM consultants headquartered in East Kilbride, Scotland, says that through implementation of JIT, the Scots have the potential to catch up with the United States in three years and overtake the market within five years.

One reason for Scotland's potential is that the pieces are all in place. Scotland has a well-established electronics manufacturing base as well as a large pool of local suppliers — a characteristic shared by the U.S. market. But Scotland has two other qualities that are not duplicated Statesside. Suppliers, original equipment manufacturers (OEMs) and the end market are geographically close, and, perhaps more important, the existence of the SDA as an electronics advocate and facilitator. "No other country in the world, outside Japan, has this set of circumstances," Berg adds.

The role of the SDA

The SDA received its charter in 1975 through an act of Parliment. Its formal objectives are to further the economic development of Scotland and to promote industrial efficiency and international competitiveness. These goals are accomplished through financial assistance to develop new technology and to assist small businesses. The SDA is also a major industrial property owner and local area developer. In 1985, the SDA held 20 million square feet of floor space in over 220 locations.

Scottish electronics plants by industry sector in 1986



Source: Scottish Development Agency Electronics Division

The SDA, in cooperation with PRTM and international OEMs, is providing JIT educational seminars for suppliers as the main thrust to get the JIT ball rolling. But according to Dominic McKay, senior project executive of the electronics division of the SDA, there are other avenues the SDA is starting to pursue to promote JIT. The only problem McKay sees is that JIT sourcing is not catching on as quickly as he expected. As the cornerstone to Silicon Glen's growth, he says that there is still "room for improvement" in convincing vendors to adopt JIT sourcing.

> JIT sourcing is a long-term partnership between a manufacturer and a supplier

To get things moving a bit faster, McKay says, the SDA is: sponsoring a JIT Club for OEMs and vendors to get together and discuss problems and experiences with JIT; offering financial packages through the Industry Department for Scotland (IDS) — the industrial arm of the Scottish Office — actively seeking senior-level executive support for JIT sourcing; and running seminars for government agencies such as the IDS, the Highlands and Islands Development Board, the East Kilbride Development Corp., the Cumbernauld Development Corp. and the Livingston Development Corp.

Peter Carmichael, director of both the small-business and electronics divisions of the SDA, although enthusiastic about JIT, is concerned that there may be some disillusionment over JIT. That is, some will try it, find the results are not immediately forthcoming, and so abandon their plans and go back to the old ways. If this happens then JIT sourcing will never have a chance to get off the ground.

Another complaint is that the OEMs will bully the small suppliers by using JIT sourcing as an excuse for more sinister motives. "My only fear," Carmichael says, "is that if it is not done in a concerted way, [JIT sourcing will] just transfer inventory from the OEMs to suppliers."

The word from the OEMs

Most OEMs, however, would be quick to respond that JIT is anything but "the flavor of the month." Instead, most are looking to invest in long-term relations with suppliers. By definition, JIT sourcing is a long-term partnership between a manufacturer and a supplier, not coercive strategy for short-term gain. It is founded on trust that a quality product will be delivered on time when needed and involves sharing information and forecasts between the vendor and the manufacturer. This might result in a more expensive input initially, but the bottom line is that the total cost will invariably be lower. It is the reduction in total cost that will give the OEMs a clear advantage in the international marketplace.

Honeywell Control Systems Ltd., a division of Honeywell Inc., located in Motherwell, Scotland, found that in 1984 and 1985 the vendors with the best track record were those from offshore. Specifically, 90% of the materials received by Honeywell from local vendors were unacceptable, leadtimes to vendors were 12 weeks, promised shipping dates were often not met and price increases demanded by the vendors averaged double the running rate of inflation. As a result, Honeywell decided to pare down its vendor base and introduce a new purchasing strategy called the assured supply program (ASP).

Through ASP, Honeywell invited some key vendors, both local and international, to participate in a long-term "partnership" in return for the vendors' commitment to provide Honeywell with "maximum service and support in all business conducted," says Honeywell. Some of Honeywell's objectives include just-in-time sourcing, achieving zero defects in inputs and outputs, reducing leadtimes, shortening product cycle times and set-up times as well as improving communication.

By August last year, 12 vendors had formally entered into an ASP agreement with Honeywell and another 12 had been invited. Already acceptance rates with partnership vendors had risen to 98%, on-time delivery was up to 100% and vendor's leadtimes had come down to two to four weeks. Honeywell estimated that 100 partnership vendors would be sufficient to supply 80% of its needed materials.

With JIT sourcing, the total cost will invariably be lower

Another example of pressure from an OEM is Hewlett-Packard Co.'s Queensferry, Scotland, microwave and communications plant. HP started this operation in 1984 with JIT as an integral feature and is currently supplying the European market with about $1 billion in sales a year. The division estimates that about 60% of the finished-good cost comes from materials, with about 40% of that coming from subassemblies and 14% of that is from sheet metal for cabinets.

HP, traditionally a batch producer, is attempting to shift to a JIT philosophy both internally and in cooperation with its local suppliers. As subassemblies are such a high-value input and sheet metal is so bulky, HP's strategy has been to focus on reducing its inventory of these two components. One JIT supplier of sheet metal, Fife Fabrications of Glenrothes of Scotland, is cooperating with HP on improving forecast visibility, implementing ship-to-stock, reducing cost and improving delivery.

By shifting from multiple sourcing to single sourcing, Hewlett-Packard is getting its suppliers to only produce what is needed when it is needed and to try to make JIT as attractive to them as possible. So far, the company has been able to reduce its inventory from four months to less than two months, its build cycle of eight to 12 weeks to less than two weeks, and its customer leadtime from 12 weeks to less than four weeks.

Motorola Inc.'s Semiconductor Products Sector in East Kilbride, is also aggressively pursuing JIT sourcing. So far, the chip maker has reduced its total vendor list by around 90% and its active vendor list by around 50%. It has also managed to cut its own inventories by two-thirds. The East Kilbride facility is moving toward single sourcing its wafers and wants to do the same with its quartz and chemical suppliers. Chemical sourcing is now 100% local.

Motorola's objective is to turn its inventory over a minimum of 10 times a year, reduce its cycle time to 30 days — or 2 times theoretical standard — and ultimately get all of its suppliers to use JIT sourcing. The company claims to had a great deal of success with its JIT drive so far, but Barry Waite, vice president and general manager of the East Kilbride plant, admits that there is still a long way to go. As far as Motorola's vendor relationships, Waite stresses his company's commitment to reducing the number of suppliers and establishing long-term relationships with those left. ☐

NCR — Ensuring the vendor is dedicated

Although NCR Ltd. only adopted JIT a year ago, the automatic bank-teller machine (ATM) manufacturing operations are making great strides toward streamlined operations. Already inventory has been slashed by $75,000 (£ 50,000), floor space has been reduced by approximately 400 square feet, product cycle time has dropped from 10 weeks to 10 days and customer order response time has dropped from eight months to six months.

William Patullo, director of manufacturing at NCR (Manufacturing) Ltd., in Dundee, Scotland, puts the improvements down to a combination of both internal applications of JIT as well as JIT relationships with suppliers. The first thing the company did when it introduced JIT back in 1985 was to set up an in-house education program and to draw up a list of projects that would aid in reducing inventory, Patullo says. After the internal program was under way, NCR went to its vendors and established partnerships with them in order to get just-in-time delivery of its higher-cost and higher-volume inputs.

The goal, says Patullo, is to create long-term relationships with a small number of vendors. To encourage JIT sourcing, NCR will provide partnership vendors with 12-month forecasts and six-month rolling forecasts, vendor certification for 100% quality, and provide an agreement for a minimum order quantity of raw materials. The vendor benefits by having secure long-term business, less rework, prompt payment of receipt of goods and improved capacity for business planning.

The pressure to conform to JIT is as intense as the competition to be a JIT supplier. Already NCR has slashed its vendor base by over one-third, from 333 in 1983 down to around 200 by the end of 1986. The fatalities are those companies that refuse to adapt to JIT.

The Scottish Development Agency, Scotland's equivalent of Japan's Ministry of International Trade and Industry (MITI), is attempting to educate local suppliers about JIT. Many believe that if the local supplier does not jump on the JIT bandwagon soon, the business that was once assured will be given to a supplier that complies with JIT sourcing. The result being that the business will be lost — maybe forever. ☐

The competitive advantage: Suppliers must deliver it

Component and production equipment suppliers must do more than develop high-tech products for their customers

By Tim Mead

As much as the fortunes of computer and communications companies rest on their ability to deliver the solutions demanded by their customers, so do those of component- and production-equipment suppliers. They, too, must solve the problems faced by their customers, the IBMs and AT&Ts of the world.

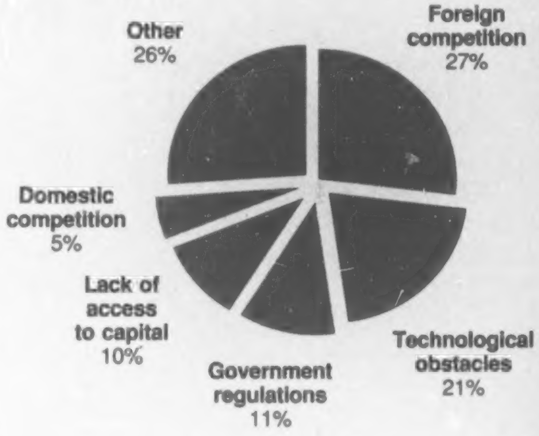
Suppliers are mistaken if they think new bells and whistles alone are enough to sell more chips and testers in 1987. Technology, though a major concern of computer and communications equipment producers, is *not* their biggest problem. It's competition — particularly from abroad.

In a recent survey conducted by ELECTRONIC BUSINESS, 27% of the managers at computer and communications companies who voiced their opinions listed foreign competition as the biggest single issue facing their companies this year. Another 5% singled out domestic competition as their No. 1 concern. "We must become more competitive worldwide," wrote one manager. "Total mismanagement of American manufacturers will create a declining situation," said another.

Providing affordable state-of-the-art products to customers is, of course, one way to make them more competitive. And the survey indicates that computer and communications companies will certainly be receptive to any products that can help them surmount technological obstacles.

But suppliers can and *must* do more. They must become competitive on a worldwide basis to continue to provide their U.S. customers the best products at the best price. They must be willing to experiment with new delivery strategies such as just-in-time to help their customers hold down inventory costs. They must provide greater levels of after-sales service to keep their customers' design centers and manufacturing plants operating at peak efficiency.

Major issues facing computer and communications companies in 1987



Source: ELECTRONIC BUSINESS

Suppliers that do not make those extra efforts are going to find themselves out of business. And it may happen sooner than they think. Gone are the salad days when a hardware manufacturer could sell a *Fortune* 1000 customer a machine it really didn't need. Gone, too, is the investment tax credit, a crutch used by many equipment makers to justify outlays for new production equipment.

Here, instead, are tough customers. The buyers of computer and communications equipment demand higher levels of performance for lower prices, transparent networks and the like. They know what they want, and they won't buy anything less. Equipment producers, in turn, are demanding more of their suppliers. They know what they want, too — components and equipment that will make them more competitive. ☐

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Electronic Business

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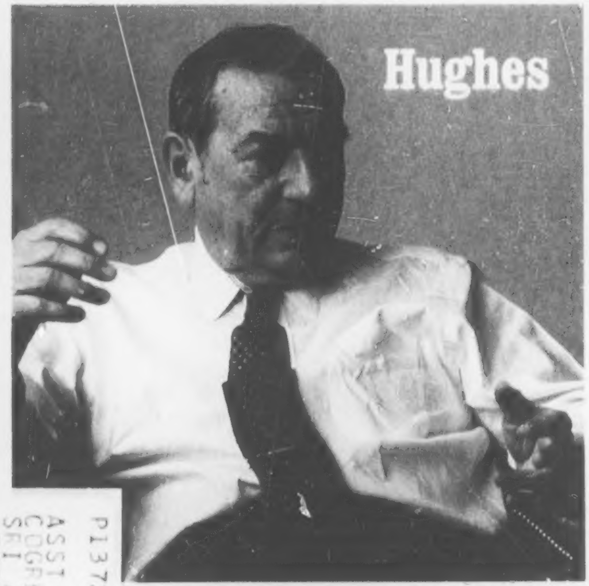

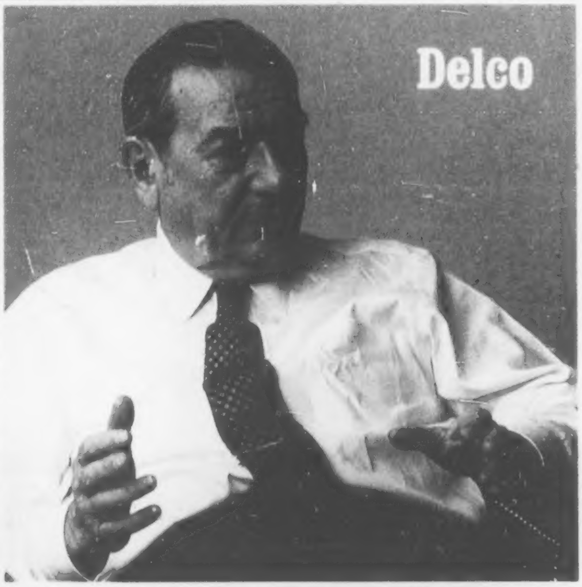

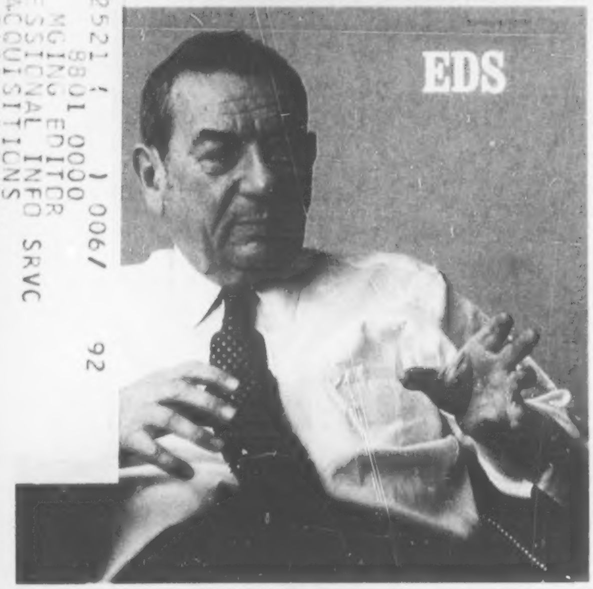

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Cover photo/Robert Burroughs

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BPA ABP

Distributors are confident, despite PCBs moving offshore

The movement of PCB production to the Far East doesn't worry distributors. Should it?

Offshore production, a cost-saving tactic increasingly being embraced by U.S. electronic equipment manufacturers, may not devastate industrial distributors as much as it would appear it does.

Sales forecasts for U.S. distributors remain squarely positive in spite of a dramatic rise in the number of equipment makers that are moving their printed circuit board operations to the Far East. The trend would seem to work against distributors, given that they have very little presence in the Pacific Rim.

Nevertheless, optimism abounds for distributors. Their shipments will rise 19% this year and 25% next year, predicts Cahners Economics. They'll grow 12% in 1987 and again as much in 1988, estimates Montgomery Securities. They'll expand 5% to 10% yearly, figures Arrow Electronics Inc.

What underlies their enthusiasm? Most industry observers and executives contend that the large portion of distribution's customer base is not moving offshore. That base, furthermore, already has suffered a mild recession and is on the road to recovery.

"By and large, the move offshore has not affected distributors because the companies that have moved production out of the United States have been manufacturers of personal computers, disk drives and others. And that's always been an OEM [original equipment manufacturer] business," says Stephen P. Kaufman, president of Arrow Electronics Inc. in New York, explaining that component suppliers usually serve large-run accounts on a direct-sales basis instead of through distributors.

"The markets served by distributors — R&D [research and development] labs, military contractors and manufacturers with short-run production schedules — haven't gone offshore," Kaufman adds. He stresses, however, that the No. 2 distributor has not dismissed the possibility of setting up shop in the Far East. "Arrow always has had a global posture," he says, noting the company already has franchises in Canada, England and West Germany.

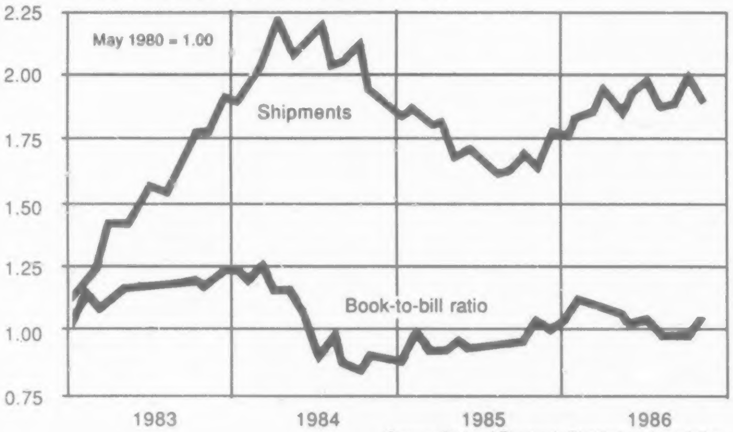
Arrow, like most other top distributors, started to build momentum last fall. Its sales climbed 4% in the third quarter, while Hamilton/Avnet Electronics' rose 10%. Ducommun Inc., Kierulff Electronics' parent, experienced an 11% increase in sales during the three-month period — slightly less robust than the 17% gain in distribution sales at Wyle Laboratories.

Equally significant, most distributors saw their order rates climb in the last few months of 1986. Such activity was reflected in their book-to-bill rates, which hit 1.0 in September and moved upward.

Cahners economist Cheryl Patstone believes that such indexes augur well for the distribution industry this year and next. She says that economic corrections already have occurred in several of the markets served by distributors, notably computer and communications. And she already sees signs of component prices firming — welcome news to Kaufman and other chief executives of distribution companies.

TIM MEAD

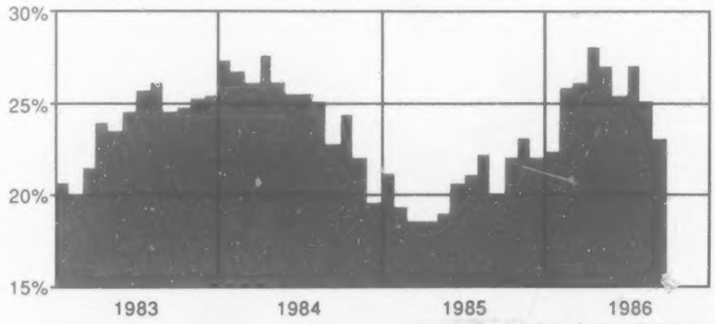
Distribution business index



Source: National Electronic Distributors Association

Distributors' share of IC shipments

(Percentage of U.S./Canadian shipments)



Source: Semiconductor Industry Association

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, showed a mild decline in the second quarter, followed by a slight recovery in the third quarter. For 1986, production is expected to be up a scant 0.9% from the previous year. This year, steady improvements are forecast thoughout the year pushing production up 3.9%.

The Cahners Early Warning Indicator (CEWI) is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index. It forecasts probable business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 100.3 level forecasts using the CEWI for the end of this year indicates that the average for all of 1987 should be 3.9% above 1986.

Readers can obtain a brochure explaining the CEWI method from Cheryl Patstone, economist, Cahners Economics Department, 3021 Tisch Way, Suite 100, San Jose, Calif. 95128.

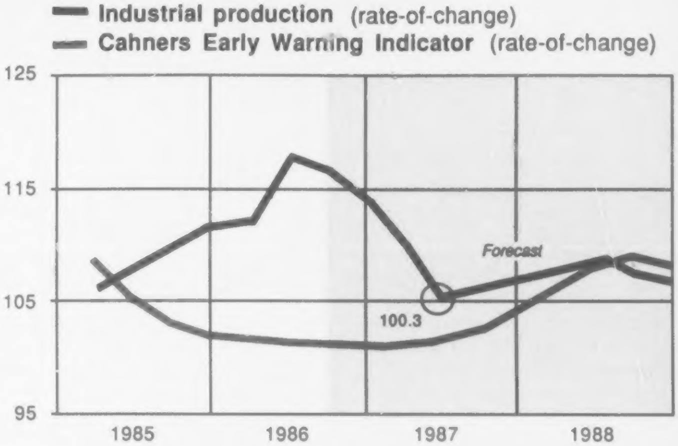
Electronic components

Component production was virtually flat during 1986. In the third quarter, manufacturers increased their levels of output by 0.5%, just enough to compensate for the previous quarter's modest decrease. Early reports for the fourth quarter indicate that production will again show little change. Now that most segments of the industry are recovering from last summer's order slump, we expect production to begin improving gradually. After declining by an estimated 5.1% in 1986, output should rebound 7.7% this year (with the largest gains occurring in the second half). Production will continue to accelerate in 1988, reaching 16.2%.

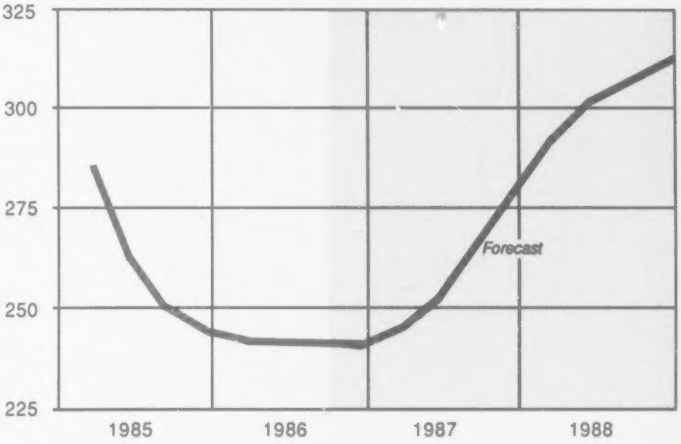
Equipment, instruments and parts

Following three consecutive quarters of improvement, instrument production fell 1% in last year's third quarter. A slowdown in U.S. business investment was largely responsible for that slump with spending cutbacks in 1986 affecting many segments of the instrument industry, including factory automation equipment, and scientific and engineering instruments. Production decreases should continue into early 1987, holding this year's annual growth to just 1.3%, down from an estimated 3.1% gain in 1986. But the market is expected to get back on an expansionary track before midyear, paving the way for a more substantial 9% growth rate in 1988.

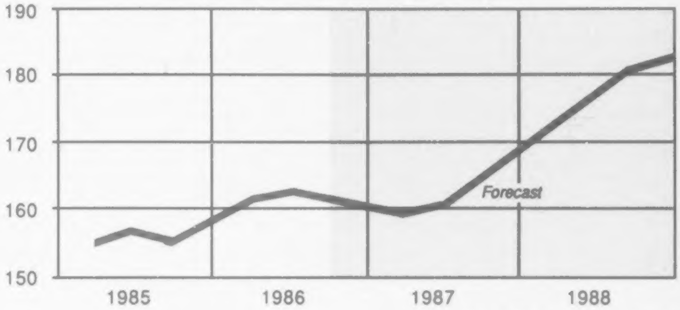
Economic indicators



Industrial production: Electronic components
(1977 = 100, quarterly averages)



Industrial production: Equipment, instruments and parts
(1977 = 100, quarterly averages)



Historical data: Federal Reserve Board
Forecast: Cahners Economics

New orders
Component manufacturers received just $8.72 billion worth of new orders in last year's third quarter, a decrease of more than 14% from the second quarter. This was about double the amount of decline which normally occurs during the summer quarter. The cause of this weakness: lackluster growth in the major end-user markets, which consume large quantities of components; inventory rebuilding by those users, which had given a boost to orders in early 1986, was cut off in the third quarter when business conditions remained disappointing. Orders began to pull out of this slump in the fourth quarter and should continue to rise gradually throughout the coming year. After growing an estimated 5.8% to $38 billion in 1986, orders are expected to increase 12% this year and 21.7% in 1988.

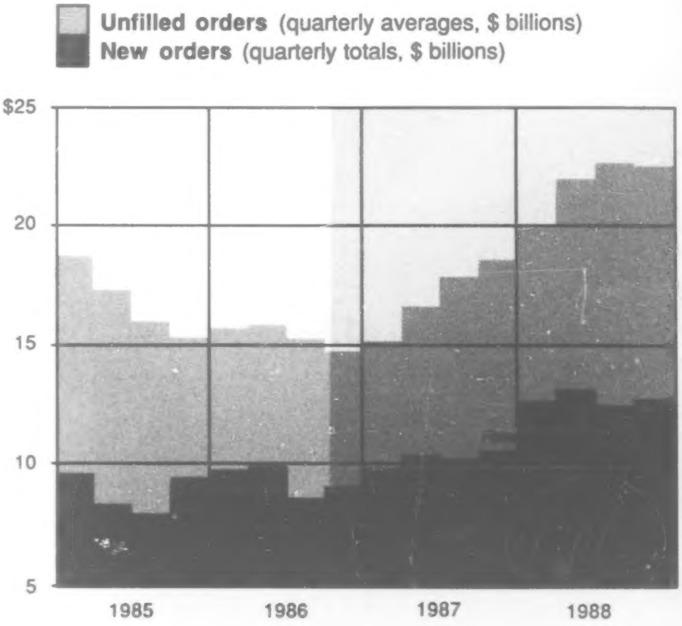
Unfilled orders
Manufacturers' order backlogs averaged $15.6 billion in the third quarter, down from $16.1 billion in the previous three months. A midyear decline in demand for components (resulting from weakness in the capital equipment sector) precipitated the reduction in backlogs. Extended plant shutdowns and continued caution on the part of buyers should prevent backlogs from growing in the fourth quarter, resulting in an overall yearly decrease of 8.3%. But backlogs are expected to build gradually throughout 1987 and 1988 with an increase of 10.7% this year (to an average of $17.3 billion) and 27.4% more next year.

Shipments
Manufacturers' shipments of electronic components were valued at $9.74 billion in the third quarter of 1986, a decrease of about 4.3% from the previous quarter but 4.7% above the level in the third quarter of 1985. Early reports for the fourth quarter suggest that volume will remain close to $9.75 billion. That will bring shipments to a yearly total of $39.5 billion, an increase of 1.6% compared with 1985. The recently reported improvement in orders suggests that shipments will begin to accelerate again by spring (shipments typically turn up 4 to 6 months after bookings). Shipments are expected to increase 6.9% this year and 17.7% next year.

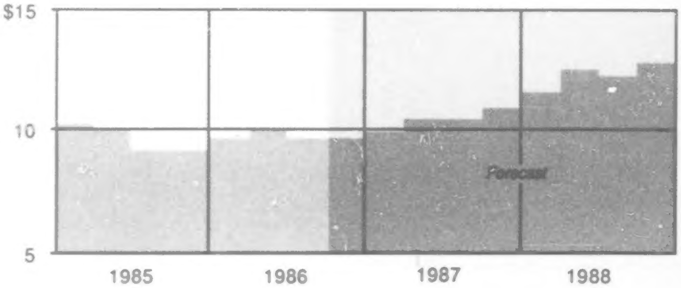
Inventory-to-shipment ratio
The component industry's ratio of inventories to shipments dipped slightly to 1.81 in the third quarter, from a level of 1.83 in the previous three months. These readings fell within the lower third of the range over the last complete business cycle, an indication that there are no severe inventory imbalances in the industry at the present time. As growth in the component market escalates this year, the ratio should be drawn even lower, probably reaching 1.6 to 1.65 by year-end.

Electronic components

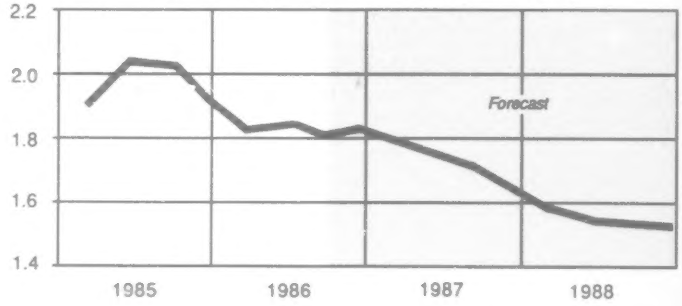
(SIC 367)



Electronic components: Shipments
(quarterly totals, $ billions)



Electronic components: Inventory-to-shipment ratio
(seasonally adjusted, quarterly averages)



Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

When you're No. 6, you have to try harder

Applicon parent, Schlumberger, may be shedding Fairchild, but Applicon continues to make money for the home office

It took staff reductions, lower hardware prices and faithful customers — but Applicon Inc. finally looks as if it may have made money last year for parent Schlumberger Ltd. How much money the CAD/CAM/CAE subsidiary makes this year may depend largely on efforts to win back electronics customers it has neglected in recent years.

Applicon — the No. 6 United States-based vendor of computer-aided design, manufacturing and engineering (CAD/CAM/CAE) systems — was expected to generate more than $2 million in operating profits on $165 million in revenue in calendar 1986. "It's been a long time coming," Applicon president Richard A. Mohrman says of the return to profitability, indicating that his company lost money in 1985 and 1984. During that time, not so coincidentally, Applicon all but abandoned its efforts to sell electronics companies computer-aided design (CAD) systems for making printed circuit boards (PCBs). The company, instead, had been focusing on mechanical CAD applications.

A combination of things has brought Applicon's health back. Mohrman points to three factors: fewer employees — Schlumberger cut 200 workers when it merged Applicon and Manufacturing Data Systems Inc. (MDSI); cheaper computers from its chief supplier — Digital Equipment Corp. (DEC); and steady customers.

Analysts credit the Mohrman's healing powers for the comeback. "He wisely recognized that Applicon wasn't going anywhere by competing head-on with IBM, Computervision and Intergraph at large accounts," says Charles Foundyller, president of market research firm Daratech Inc. in Cambridge, Mass., who figures Applicon company grew about 15% in 1986. "Mohrman repositioned the company to focus on small and medium companies."

He still has his work cut out for him. Applicon acknowledges that it has ignored two major markets in recent years — one defined by industry, the other by geography:

- To correct its shortcomings in selling systems to the electronics manufacturers, which readily bought its DEC PDP-11-based PCB layout systems years ago, Applicon plans to migrate them to newer systems based on VAX or Sun platforms. Mohrman vows that electronics customers will account for 25% of Applicon's sales by 1988; they now represent less than 10% of the subsidiary's business.

A combination of things has brought Applicon's health back

- To increase its share of the Asian CAD/CAM/CAE market, which is below 5%, Applicon is expanding beyond its Japanese base. It opened an office in Beijing two months ago, and it intends to open another one early this year in Singapore. "If we can't get 15% or 20% share of that market," Mohrman says of Asia, "we can't manage."

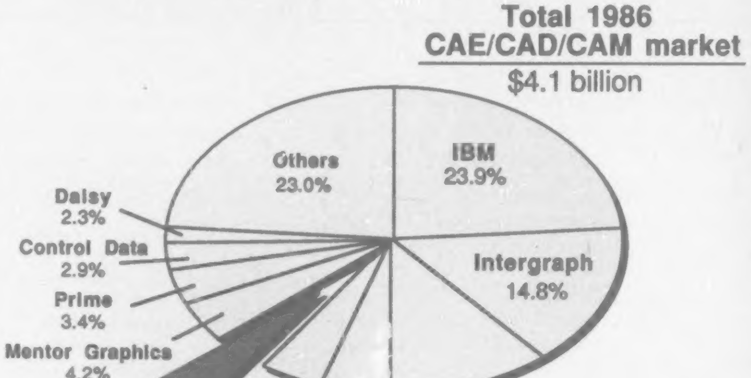
The issue of management is clearly on the minds of Applicon employees and customers these days. The Ann Arbor, Michigan-based company underwent two major executive changes last year — Mohrman replaced Alex Beavers as president of Applicon, and Michel Gouilloud replaced Jimmy Lee as head of Schlumberger's computer-aided systems group, which Applicon is a part. More disquieting is Schlumberger's proposed sale of its Fairchild Semiconductor unit to Fujitsu Ltd. Some critics wonder whether the entire bloom is off the electronics rose plucked by the late Jean Riboud, who chaired Schlumberger when it acquired Fairchild in 1979, MDSI in 1981 and Applicon in 1982.

Gouilloud assured ELECTRONIC BUSINESS that Schlumberger has no intention of selling Applicon, stressing that it complements the $6.5 billion parent company's wireline, and measurement and control businesses. IBM apparently takes him at his word. It is allowing Applicon to purchase its new 9370 line of minicomputers on an original equipment manufacturing (OEM) basis. Applicon plans to use the IBM machine as a platform for its Bravo3 applications software. Applicon will also continue to offer the software on computers and workstations made by DEC and Sun Microsystems Inc.

TIM MEAD

Applicon: Small but finally profitable

Worldwide CAE/CAD/CAM revenue of U.S. companies



Source: Daratech Inc.

Supermini makers set for super year

All the major vendors have introduced new MIPS busters. Now it's a race to the loading dock. How fast is IBM?

By Mary Jo Foley

Even though the rate of new superminicomputer announcements was unusually high last year, the rate of market growth was down. This year, the reverse will be true: fewer new model introductions but greater shipments of existing products.

"We expect demand for superminis in 1987 to go through the roof. The days of hierarchical mainframe computing are over," proclaims Ross Licero, group systems marketing manager for VAX systems at Digital Equipment Corp. (DEC).

Independent market forecasts support Licero's enthusiasm. Worldwide supermini sales will climb 12% to $17.7 billion this year — up from last year's 8% pace, according to International Data Corp. (IDC) in Framingham, Mass. The market research firm these days refers to superminis as medium-scale systems: 32-bit machines priced between $100,000 and $1 million and capable of supporting between 17 and 128 users.

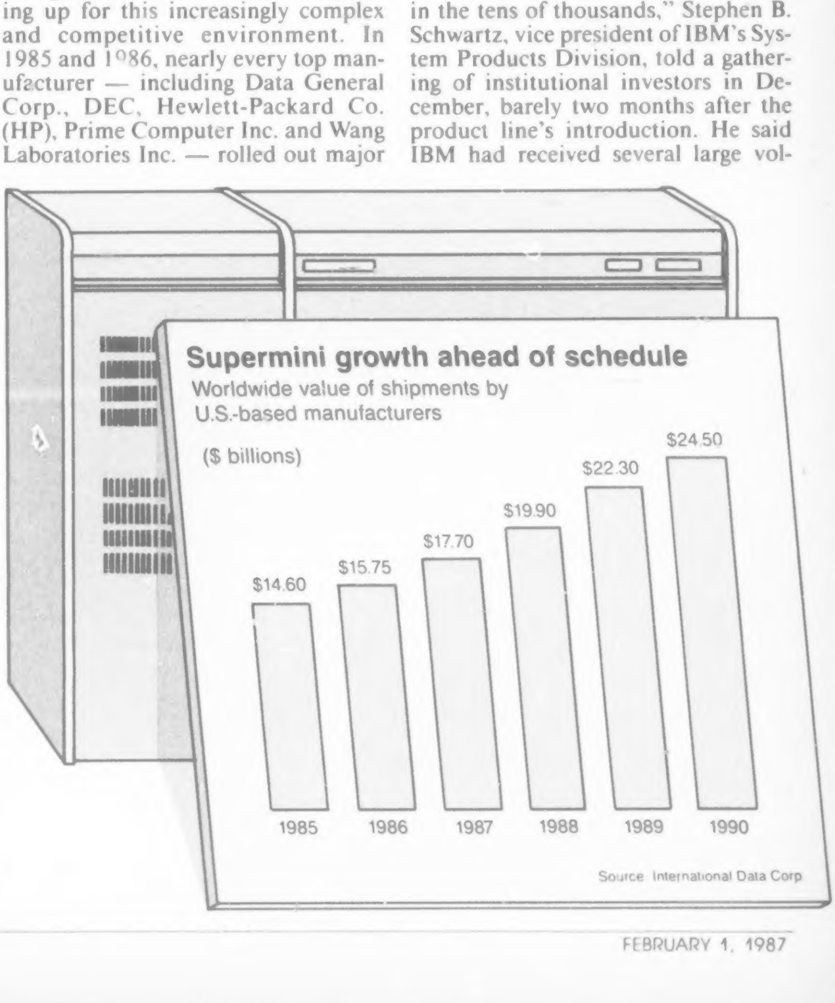
Despite robust demand for superminis, vendors will be scrapping for nearly every sale — against each other and newcomers. All of them have boosted their salesforces, notably supermini leader IBM with the addition of 5,000 employees to its worldwide salesforce of 23,000. At the same time, less established manufacturers of so-called minisupercomputers are vying for a share of the information technology dollars spent by customers for high-performance processing.

Some of the upstarts are relying on cutthroat pricing to get a foot in the door, which may be the wrong tactic. "Price/performance is less important than it's ever been," claims Marc Schulman, a securities analyst for Salomon Brothers Inc. In the eyes of customers, vendor viability, visibility and support are fast becoming the new proving ground for supermini makers. Many, nevertheless, continue to tout the processing speeds of their machines as measured in millions of instructions per second (MIPS).

Ramping up

Supermini makers have been gearing up for this increasingly complex and competitive environment. In 1985 and 1986, nearly every top manufacturer — including Data General Corp., DEC, Hewlett-Packard Co. (HP), Prime Computer Inc. and Wang Laboratories Inc. — rolled out major additions to its supermini line. In addition, IBM last year revamped two of its existing supermini lines, the 4300 and some System/38 models, and introduced a new minicomputer line known as the 9370 Information System. At least two of the 9370 models fit the supermini class, the Model 60 and the Model 90.

"Domestic orders for the 9370s are in the tens of thousands," Stephen B. Schwartz, vice president of IBM's System Products Division, told a gathering of institutional investors in December, barely two months after the product line's introduction. He said IBM had received several large vol-


Supermini growth ahead of schedule

Worldwide value of shipments by U.S.-based manufacturers

Source: International Data Corp

ume orders from big companies, citing Ford Motor Co. and United Airlines as examples. Most 9370 customers will not receive the machines until the third or fourth quarter of this year, however.

The time lag between product announcements and shipments, coupled with depressed capital spending in 1986, held down the growth of the supermini market last year. But as supermini vendors begin to produce their new lines in volume, the market should climb. IDC predicts worldwide shipments could reach $24.5 billion by 1990.

Competition for established supermini vendors is rising at an even faster rate — from below and above. Second-tier supermini makers such as Concurrent Computer Corp., Gould Inc. and Harris Corp. are targeting market niches with customized machines. Manufacturers of minisupercomputers, array processors and multiprocessors, meanwhile, are expanding their product lines and expertise downward.

Real-time processing and on-line transaction processing, for example, are Concurrent's targets for its 3200 XP products. "I run up against DEC in bidding for real-time jobs, and IBM and Tandem in the OLTP arena," says James Sims, president of $245 million Concurrent, a Perkin-Elmer Corp. spinoff.

To combat such giants, Sims is using different distribution channels and software for each market at present. And he is betting on a new component packaging technology for the future. "The major development in 1987 will be to use surface-mount technology to achieve the density [of processing power] required by the products we have under development," Sims says.

Rivalry among the established supermini vendors is likewise heating up. Price undercutting and discounting are said to be widespread, even though all of the major vendors vehemently deny they participate in these activities. "There are reports some of the competition have given away maintenance [contracts]. And they are trying to mask price discounting to prevent price wars," says Stanley Dolberg, Data General's product manager for midrange superminis.

"Margins in hardware are starting to shrink. And we don't see anything on the horizon to change that," says Fred Wang, president of Wang Laboratories. "That's why we're moving into new areas," he adds, disclosing that Wang intends to decrease its dependency on hardware as a source of revenue from 67% in 1986 to 53% in the early 1990s. Revenue gains in maintenance, services and software will offset the difference.

Battle scars

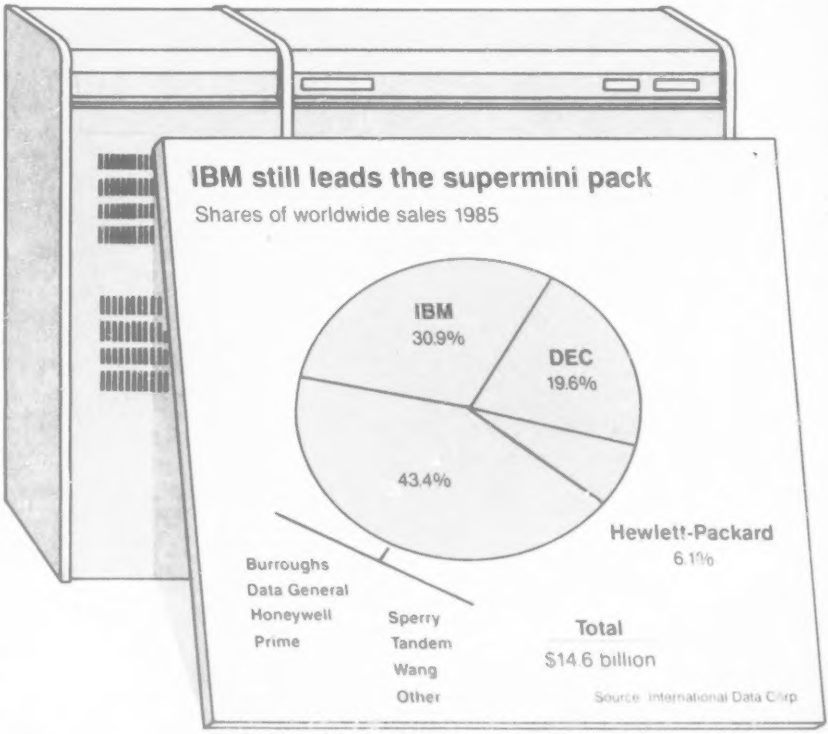
Certain computer manufacturers already have been wounded visibly by toughened-up supermini vendors. "Companies that have tried to play both ends against the middle are hurting," says Marty Grunn of the Sierra Group, a Tempe, Arizona-based market research firm. She identifies these companies as Honeywell Inc., NCR Corp. and Unisys Corp. "They thought departmental [supermini and minicomputer] systems would screw up their mainframe sales." So they emphasized their high ends (mainframes) and low ends (microcomputers), leaving everything in the middle to go its own way.

> "Margins in hardware are starting to shrink. And we don't see anything on the horizon to change that"
>
> Fred Wang of Wang Laboratories

Indeed, such companies are scrambling to correct their computer strategies. Honeywell, for instance, announced at the end of last year it would sell the majority share of its computer business to Groupe Bull and NEC Corp. Another once-feared supermini vendor, AT&T, appears to be backing away from the computer marketplace, despite its protests to the contrary. AT&T in November pulled its direct salesforce off small and medium accounts, leaving such business to value-added resellers and retailers.

The amalgamation of Burroughs Corp. and Sperry Corp. into Unisys further evidences a recognition that new strategies are needed to compete in today's computer environment. Because each company's product lines are largely incompatible, Unisys will continue selling both their supermini offerings: the 5000, 7000 and XE 550 families. "We're choosing to keep all of these products available by choosing specific niches for each," explains Peter Herman, marketing manager for entry-level and distributed systems at Unisys.

The Detroit-based company is relying on Unix for communication between Burroughs and Sperry systems, making it one of the only major supermini vendors (HP is the other) to push



Source: International Data Corp

the nonproprietary, AT&T-developed operating system. Still, fewer than 10% of all superminis currently run Unix, according to market watchers.

Driving forces

As if cutthroat competition was not enough, supermini vendors must rethink their MIPS-based strategies to stay on top, according to analyst Schulman. Customers are paying keen attention to factors other than processing power. "Buying a supermini now is more of a marriage than a simple business decision," he says. "The market is being driven by major corporate users trying to solve networking and [distributed] data-processing problems."

That could spell trouble for vendors lacking cohesive communications and architectural strategies. DEC, committed solely to Ethernet networks and its VAX computer architecture, certainly thinks so. "Those companies with different computer architectures are going to have a difficult time," says John F. Smith, senior vice president of engineering, manufacturing and product marketing at DEC. Counters IBM's Schwartz: "Why do we support different computer architectures? Because our customers demand different solutions."

IBM — at least prior to its June rollout of 103 hardware and software

IMPACT ON ELECTRONICS

Supermini input could raise output

If printer manufacturer Printronix Inc. is any indication, customers will find the new generation of superminicomputers well worth the wait.

The $132 million Irvine, California-based company last August installed a Digital Equipment Corp. VAX 8650 — one of several models that comprise DEC's second generation of VAX minicomputers. The choice of the 6.3 million instructions per second (MIPS) 8650, base price $300,000, was hardly a surprise.

Printronix, like so many customers of second-generation equipment, was a first-generation customer of DEC. Before installing the VAX 8650, the company relied on four VAX-11/750 minicomputers to design its software, firmware and printer hardware, according to management information systems director Victor Fitzsimmons. Now, the VAX 8650 alone is supporting 40 to 50 programmers using various DEC and third-party engineering software-development tools; Anvil computer-aided design software; the Anysis finite-element analysis tool; and Patran, a graphical modeling tool.

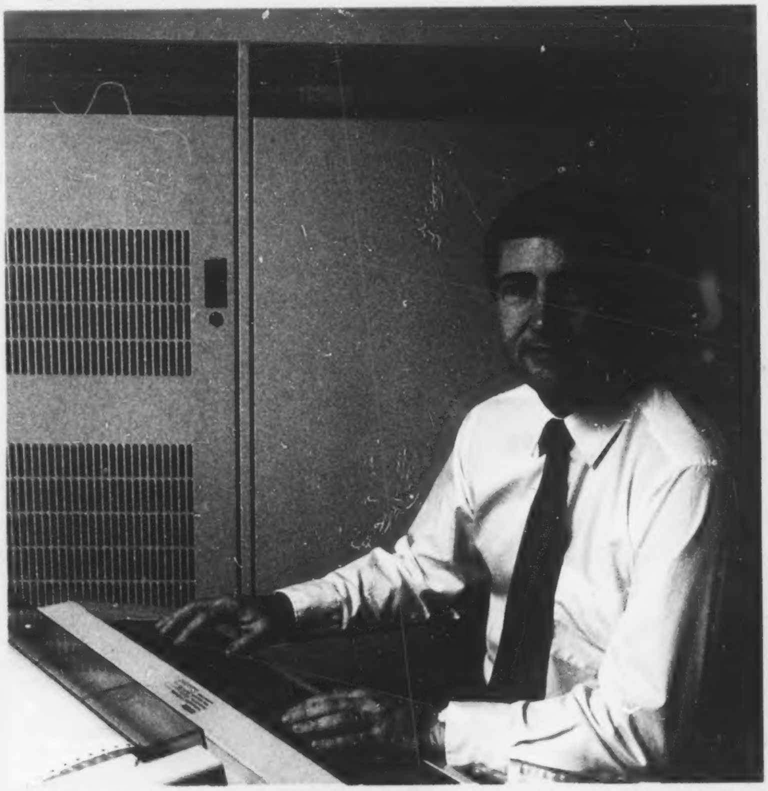
Printonix's VAX 8650 interfaces with other manufacturers' systems via DEC's Ethernet local-area network. It is connected to an IBM 4381 mainframe running Management Science America (MSA) Inc.'s integrated business/manufacturing management software; a Telesis printed-circuit-board design system (five workstations connected to Ethernet via a Telesis network); and an Interleaf Inc. computer-aided publishing system (running on four Sun Microsystems workstations).

In addition, Printronix is in the process of connecting its VAX 8650 to other VAX machines at its four remote manufacturing and distribution sites: Camarillo, Calif. (VAX-11/750); Malden, Mass. (VAX-11/750); Singapore (VAX-11/750); and the Netherlands (VAX-11/730).

"It's a way for us to link together all those islands of engineering automation to gain the next level of productivity," Printronix chief executive Robert A. Kleist says of his company's efforts to link all of its VAX hardware together. "We're finally starting to use computers in the computer industry."

Other supermini hardware vendors never were really in the running, as far as Printronix was concerned. "We looked at IBM hardware and a lot of attached processors, like Celerity," Fitzsimmons says. "We also looked at other VAX models. But all the software we use in engineering is written for VAXes. And the 8650 is a fast machine for the money."

M.J.F.



James Caccavo

PRINTRONIX' MIS DIRECTOR VICTOR FITZSIMMONS: "All the software we use in engineering is written for VAXes. And the 8650 is a fast machine for the money" products designed to fill out its somewhat shaky System/36 and System/38 lines — was notorious for its networking and operating-system software compatibility shortcomings. The jury is still out as to how far these enhancements will go toward solving IBM's problems in its midrange computer line.

Market watchers are focusing more intently on Big Blue's newly announced 9370 family. The attention has been far from all positive, despite the fact that the 9370s do significantly extend IBM's 370 computer architecture. The processors reportedly will be capable of speeds from 0.5 MIPS to 2.5 MIPS and priced at $31,000 for the entry-level Model 20, to $190,000-plus for the high-end Model 90. But Gartner Group analyst Craig Symons, for one, forecasts that IBM's price/performance advantage will be smaller than expected once the machines are available later this year. If IBM was counting on the time lag between announcement and shipment putting a damper on its competitors' supermini sales, it was sorely mistaken, both analysts and other supermini vendors agree.

"IBM will sell a lot of 9370s in the coming year to the part of its customer base that won't move to greener pastures," says Schulman. In the meantime, those who refuse to move on "are buying from DEC or not buying at all." Still unaddressed are IBM's office-automation and personal-computer software integration strategies. Adds the Salomon Brothers analyst: "The 9370 announcement is only one step in the right direction."

Customers unruffled

Time lags appear to be having little effect on Hewlett-Packard and other competitors experiencing delays in shipping new products. "We've found that there is some anxiety among our users. People would like to see the machines sooner," HP marketing manager Timothy Haney says of his company's new Spectrum series of minicomputers. Introduced a year ago, after an estimated $200 million development effort, the new machines will not be available to customers until the third quarter of this year. "Generally, people seem willing to wait," he says. "There haven't been any mass migrations [from HP hardware to competitors' machines]."

HP's new Spectrum series is based on a reduced-instruction set architecture (RISC). Products include the HP 3000 Model 930, with a processing speed of 4.5 MIPS and a price tag of $225,000; and the Model 950, at 6.7 MIPS, and priced at $300,000 to $350,000. Due to the difficulty of designing the new computers so they will be able to run the applicatons software written for HP's old machines, neither the 930 nor the 950 is expected to ship before the third quarter of 1987. HP is relying on the current high-end of its 3000 line, the Model 70, to take up the slack until the new models become available. (In May, HP introduced the technical version of its Precision Architecture: the HP 9000 Model 840, which comes in at 4.5 MIPS and $113,500. The 840 began shipping in November.)

HP had little choice but to take a risk on RISC. "Its conventional architecture had plainly run out of steam," says Salomon Brothers analyst Mona Eraiba. Customers do not care about the underlying technology, she says; they are interested in the ease of migration from one architecture to another. So far, it looks as if HP will be able to make this transition fairly smoothly. She also praises the line's other features — notably its multiprocessing capabilities, which speed up a computer's problem-solving tasks by having several processors work on multiple problems concurrently.

> If IBM was counting on the time lag between announcement and shipment putting a damper on its competitors' supermini sales, it was sorely mistaken

HP traditionally has positioned its 3000 products in the commercial arena, though they have sold well into technical applications. It has grander plans for the 930 and 950 models. The systems initially will be targeted at computer-aided design and manufacturing (CAD/CAM), computer-integrated manufacturing (CIM), and general business customers, as well as more specialized technical fields, such as movie animation, seismology and the like.

Like HP, Data General is banking on its new line of superminis to open new markets. The Westboro, Mass., company in December unveiled its MV/15000 series, available for immediate delivery. "It's a bit uncharacteristic for DG — it offers good technical as well as commercial performance," says product manager Dolberg. More in character, the MV/15000 is priced low: $57,200 for the entry-level Model 8 to $204,500 for the high-end Model 20. DG also will target the MV/15000 to its traditional customer bases in healthcare, banking, insurance and petrochemicals.

Not to be outdone

Towering above all the other supermini companies, at least in terms of growth, is DEC. Within the past year and a half, the company rolled out an entirely new VAX line, ranging from the $53,200 VAX 8200 (1.06 MIPS) to the $369,000 VAX 8700 (6.36 MIPS). (Most industry watchers consider its high-end VAX 8800 a mainframe. DEC refers to the $586,000, 12.72 MIPS machine as a supermini.)

"DEC's momentum, if anything, is accelerating," says analyst Schulman. By next fall, the company could debut a multiprocessing version of its new line (dubbed the "MultiVAX"), he predicts, augmenting demand even further. "IBM has a very tenuous lead in departmental computing," adds Sierra Group vice president Grunn. IBM's 9370 announcement might postpone DEC from becoming the premier supermini vendor, but only by a year, she says. Gartner Group's Symons claims DEC already is the No. 1 in terms of supermini revenue.

Demand for DEC's new line, as expected, is obsoleting much of DEC's VAX-11/700 family of computers. What is surprising, however, is the commercial demand created by the new line. Currently, DEC is selling 50% of its VAX 8000s into its traditional scientific/technical stronghold; but the other half is being snatched up by commercial companies. The insurance and education markets have proven especially strong for the Maynard, Mass., company, says DEC's Licero. He claims 20% of DEC customers that buy the VAX 8000s for engineering/scientific purposes are using them for commercial applications; about 14% of all VAX 8000 customers that buy them as commercial processors also are employing them as scientific processors.

"We're struggling to keep up with demand," boasts Licero. "We were in the right place with the right products." If the newly introduced lines of DEC's rivals do even half as well, the supermini market truly may be on its way to a new heyday. □

Material handling: When less is more

As capital spending goes, so goes the market for customized material handling systems for electronics manufacturers

By Bruce C.P. Rayner

Automated material handling systems — integrated computer-controlled equipment that stores, moves and handles inventory — are big-ticket items. As the electronics industry recovers, investment in such systems is being evaluated more carefully and critically.

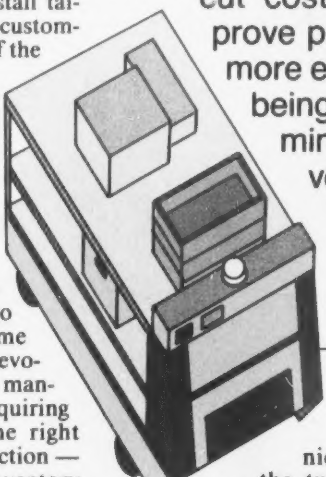
As a result, vendors are taking particular care to design and install tailor-made systems to fit their customer's individual needs. Many of the major players — Eaton-Kenway, a division of Eaton Corp., Harnischfeger Industries, Litton Industries Inc., SPS Technologies and Stanley-Vidmar Inc., to name a few — are following this course.

These electronics-oriented material handling systems are partly a response to the revolution of just-in-time manufacturing (JIT) and the evolution of computer-integrated manufacturing (CIM). JIT — acquiring high-quality materials at the right time and right place for production — is convincing managers that inventory of raw materials, work-in-process (WIP) and finished goods must be minimized if costs are to be controlled; CIM provides the practical engineering to accomplish this.

In the early part of the decade, IBM engineers designed the fully automated materials distribution center at Big Blue's Charlotte, N.C., facility and hired Litton and Rapistan, a Lear Seigler company, to install the equipment, says IBM. More recently, IBM teamed up with Litton and Rapistan to install the automated storage, retrieval and handling system that is the bloodstream of IBM's new showcase Proprinter plant in Charlotte.

Lloyd Robertson, vice president of marketing at Litton's Florence, Ky., industrial automation systems group, believes in the need for close cooperation and communication between the vendor and customer in developing a CIM environment. Without communication, he says, the two will end up speaking different languages.

As companies try to cut costs and improve productivity, more emphasis is being placed on minimizing inventory and improving throughput and turnover



At the same time sophisticated material handling systems are gaining popularity, the systems themselves are getting smaller and closer to the production process. As companies try to cut costs and improve productivity, more emphasis is being placed on minimizing inventory and improving throughput and turnover.

IBM's Charlotte distribution center has adapted to the changing times. Since its installation, there has been a tremendous change in attitude toward storage, says Joseph Sullivan, manager of distribution engineering at IBM in Charlotte. Everyone now is acutely aware of the carrying cost of inventory, he says. Compared to when it was designed in 1980, the distribution center now has much higher turn rates and stores a wider variety of parts. Turnover is getting faster and faster, says Sullivan, with material moving more rapidly from the receiving dock to the factory floor.

Team efforts

But the massive material handling jobs that exist today still require enormous resources. So there is a growing tendency for material handling companies to combine forces and bid as consortiums. Many in the industry, including Adolph Kannewurf, director of marketing at Harnischfeger Engineers Inc., a wholly owned subsidiary of Harnischfeger Industries, believe more joint ventures will be seen in the future. The financial and technical synergies, Kannewurf says, make these cooperative efforts appealing.

A recent case in point is the $167 million contract that Harnischfeger Engineers, Eaton-Kenway and Morrison-Knudsen won for a new high-tech distribution center at the New Cumberland Army Depot near Harrisburg, Pa. The joint venture goes under the name of MHK Associates.

The contract, announced last September by the Baltimore office of the Army Corps of Engineers, is for the construction of a 1.8 million square-foot fully automated distribution warehouse, covering 42 acres, to be completed by late 1989. The center, which will house mechanical, electrical and electronic parts, will supply 58% of Army supplies worldwide and 90% of Army stock to the U.S. forces stationed in Europe, says an Army Corps of Engineers spokesman. It is one of three such distribution centers planned: the other two are in California and Texas, the spokesman says. Morrison-Knudsen will build the center while Harnischfeger Engineers and Eaton-Kenway will design and equip the warehouse.

Forecasts differ

Coming off healthy growth rates in the 20s and midteens through much of the past decade, some optimists expect the market for automated material handling equipment to remain buoyant. Others are not so sure that demand for high-tech material handling equipment is still there.

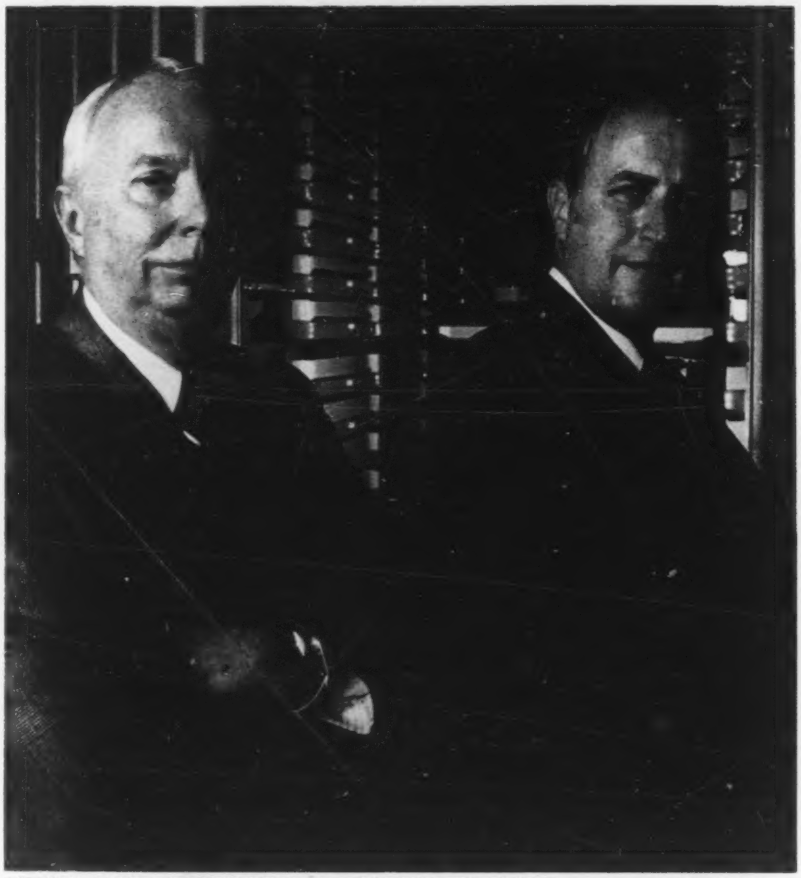
Adam Zais, director of CIM services at International Data Corporation (IDC), for example, estimates the U.S. market for automated material handling equipment — automated packaging and warehousing, robotics, automatic guided vehicles (AGVs) and automated storage and retrieval systems (AS/RS) — to grow to $2.7 billion by 1991, from $1.17 billion in 1986, at an 18.2% compounded annual growth rate.

Robert Goosman, the 1986 president of the Material Handling Institute Inc., the national trade association for the industry, and the president of Stanley-Vidmar's newly acquired automated systems division formally named ESSCORP, believes the compounded annual growth rate for the industry will be between 15% and 18% through the end of the decade.

Zais says that as manufacturers begin to work toward the factory of the future, there will be a fair amount of spending in the automated material handling equipment area. Unlike other areas of CIM, automated material handling equipment offers concrete quantitative benefits and relatively quick payback, comments Zais. The time it takes to design and install these systems is often two years or more. This necessitates careful planning and substantial investment of both human and financial resources.

Education first

As technology penetrates further into the workplace, the need for education at all levels becomes more pressing. Litton is one company that is doing something about teaching and training. The company claims that the key to its market position is the "heavy emphasis on systems analysis, software development, project management and systems integration" together with further developments in automated material handling equipment and flexible manufacturing.


Robert Fischel/Picture Group

LITTON's LLOYD ROBERTSON (left) and BRIAN SANFORD: The company claims that the key to its market position is the "heavy emphasis on systems analysis, software development, project management and systems integration"

To enhance its role as a market leader in automated material handling systems and to encourage the team spirit, Litton industrial automation systems group is setting up a $10 million technical/education center at its 100-acre Hebron, Ky., facility near the Greater Cincinnati Airport. Brian Sanford, vice president of sales at Litton's automated systems division facility in Hebron insists that "education is a constant part of our selling effort."

"The *Fortune* 100 companies remain our primary customers for automation," says Sanford, and account for about 90% of the group's business. About 99% comes from the *Fortune* 500, he adds. "Five years ago," says Sanford, "many of these companies were buying their first systems, now a lot are learning that they have to buy more carefully next time." Litton is hoping that many of these careful shoppers will take advantage of its new education center.

The center will be completed in April of 1987, says Robertson, and will include a 150-person auditorium, demonstration rooms, laboratories and display rooms. It will show off the latest in automated material handling equipment as well as educate company representatives in all facets of Litton's approach to systems integration.

Erector sets

Goosman of Stanley-Vidmar sees systems integration as a significant market but expects much of the material handling equipment growth to be at the departmental level, initially creating islands of automation. Later, when the equipment is in place, he says, the emphasis will shift to networking the departmental modules together. Goosman sees the evolution of the "erector set" strategy as an important trend in the material handling industry especially for those companies unable to finance a large integrated system. Defined loosely in terms of building blocks, this strategy enables a company to buy integrable automation equipment one piece at a time. The system would grow as the company grows.

Clark Material Systems Technology Co., a division of Clark Equipment

Co., of South Bend, Ind., is following Goosman's erector set strategy. David Hanna, business manager for robotics and AGVs with Clark's technology company, says that the company is targeting the smaller customers and has tried to structure all their products as off the shelf.

Using its 130 dealerships across the country, Clark is marketing off-the-shelf AS/RS, AGVs, robotics and material control systems, says Hanna. The company is getting away from the custom software and big AS/R systems because of the drop in demand, he says. Instead, Clark is focusing on the building-block marketing strategy for smaller customers that want some automation but cannot afford a complete system, Hanna says. Automation is rippling down from the *Fortune* 500 corporations to smaller companies employing 50 to 60 people and it is here that Clark hopes to capitalize, he comments.

The AS/RS market

One significant component of the automated material handling market is AS/RS — an integrated aisle-rack storage system, computer controlled and serviced by an automatic retrieval machine. IDC expects the AS/RS market to more than double from $450 million in 1986 to $1.2 billion by 1991, at a whopping compounded annual growth rate of 21.7%. This segment consists of both hardware — such as the large unit-loaders that service pallets and the smaller mini- and micro-loaders — and software, both for the equipment and to interface with the factory and inventory control systems, says IDC's Zais.

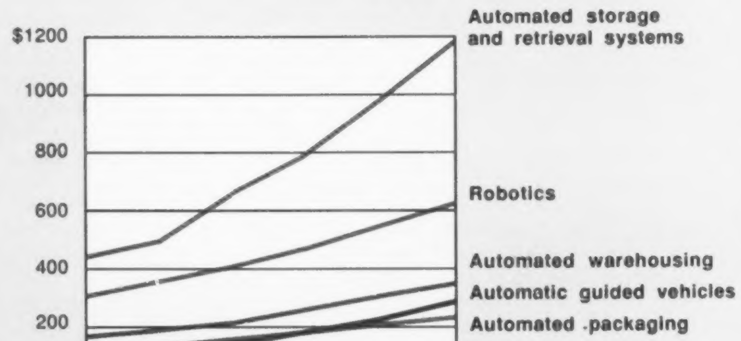
Other experts, such as Business Trend Analysts (BTA), a Commack, New York-based market forecasting firm, are not as optimistic as either IDC or Goosman, but still see growth. BTA analyst Pauline Kramer says AS/RS will increase at a 13.5% annual rate, from $253 million in 1985 to about $900 million by 1995. Most of the activity will be in the mini- and micro-load systems instead of the bigger unit-load systems, a BTA study reports. Some expect even smaller, more flexible and less expensive equipment, such as horizontal and vertical carousels, to take over from AS/R systems, especially in WIP for electronics companies.

One significant component of the automated material handling market is the automated storage and retrieval systems

A more fundamental question than what size AS/RS, says Woodrow Chamberlain, partner at Arthur Young's manufacturing consulting practice in Chicago, is: "Why am I moving the material in the first place?" Automated material handling equipment and automated storage and retrieval systems, says Chamberlain, are here to stay, but manufacturers are just more cautious about what they buy, and why they buy it.

U.S. market for automated material handling expects good health

($ millions)



Source: IDC/CIMdata, 1986

According to Robertson of Litton, AS/RS and carousels are going to be applied increasingly to WIP on the factory floor and less to large distribution centers as focus shifts from storage of materials to throughput. He expects peripheral equipment, such as robotics, testing equipment and applications of artificial intelligence, to be the most significant area of growth and development in material handling.

One such peripheral market is the automatic guided vehicle market. Zais forecasts AGV growth at a 24.6% compounded annual rate, from $100 million in 1986 to $300 million by 1991. BTA forecasts slower AGV growth at around 13% over the next 10 years.

Hard times ahead?

BTA's figures are more conservative than IDC's, Kramer says, "because of the current deceleration of the entire factory automation industry and less-than-optimal management of installed systems." Richard Walleigh, a principal at Authur Young and Company, a Big Eight accounting firm and management consultant, agrees with Kramer that there has been a lot of mismanagement and suboptimal use of technology in the past. The result is that now, many companies are hesitant to commit themselves to high-tech material handling hardware.

But while some are positive about the future, others are down right pessimistic. Many suspect the industry will be static or experience zero real growth through the end of the decade.

The reason for the expected sluggishness is due to a combination of factors. As Kramer and Walleigh point out, part of the problem is the less-than-optimal past experiences many have had with existing systems. But the less-than-healthy state of the overall economy — including the automotive, areospace and electronics industry — also contributes substantially to the downturn in demand. Whenever hard times hit, capital expenditure (including material handling equipment) goes out the window. ☐

Global sourcing: Once an option, now a necessity

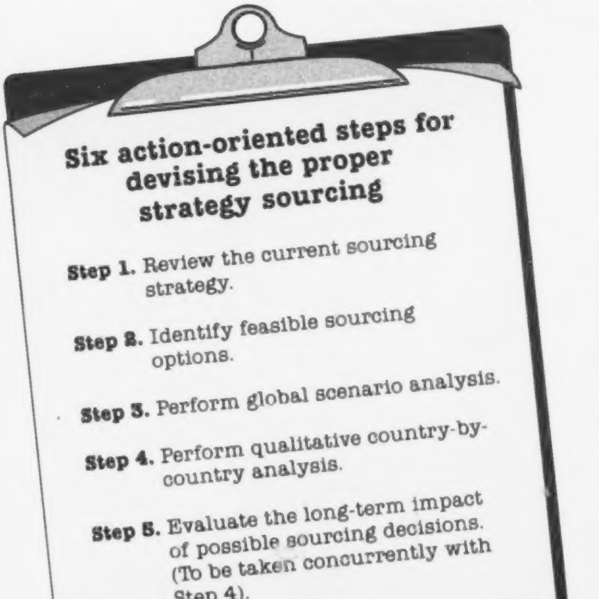
Companies that realize the world is both a market and a source for its products will prosper. Those that don't will fall behind

By Roberto Bequillard

The task of determining how and where manufactured goods and raw materials will be procured is so complex that many U.S. electronics companies try to avoid it, blindly relying on purchasing strategies that worked in the past. Sooner or later, however, such companies must recognize that they no longer can afford to dodge the chore. Government initiatives and market forces have made sourcing more important than ever.

The future of the U.S. electronics industry rests on its ability to capitalize on the international opportunities created in recent years by broadened foreign markets for its products; altered economic structures of nations; and improved communication and transportation systems worldwide.

Those developments have had a significant impact on the way in which the industry has traditionally operated, changing the rules by which companies compete today. They have affected almost all of the functional areas of an electronics company's activities, including product development, marketing, manufacturing and finance. As a result, a new dimension of complexity has been added to the managerial decision-making processes aimed at maintaining or improving the company's competitive position.



Six action-oriented steps for devising the proper strategy sourcing

Step 1. Review the current sourcing strategy.

Step 2. Identify feasible sourcing options.

Step 3. Perform global scenario analysis.

Step 4. Perform qualitative country-by-country analysis.

Step 5. Evaluate the long-term impact of possible sourcing decisions. (To be taken concurrently with Step 4).

Step 6. Develop a strategic plan.

John Kilroy

Roberto Bequillard

Where to make it?

Of all the functional areas of the company, manufacturing is one of the most critical activities facing the internationalization challenge. Labor costs are no longer the only major factor driving U.S. companies into the international arena. Proximity to components and material suppliers, industrial infrastructure, flexibility in manufacturing and reliability of quality and delivery are other factors playing a major role in the decision to source internationally.

Global product sourcing, thus, has become a key success factor for manufacturing in the present decade and beyond. Helwett-Packard Co. and Hitachi Ltd., for example, manufacture equipment and semiconductors in many parts of the world to take advantage of sourcing opportunities. The significant increase in recent years of imports of electronic products and components by U.S. companies — 300% from 1981 to 1985 — clearly indicates the response of manufacturing to this competitive opportunity.

Depending on the specific product category being considered, the impact of the sourcing decision on profitability can vary greatly. But the upside potential of a well designed and implemented sourcing strategy is so enormous that it has become an essential part of the strategic planning process of electronic companies.

Risks, rewards

As with any managerial decision, the risks of offshore sourcing must be carefully evaluated. Concerns about foreign producers' ability to manufacture products of acceptable and consistent quality, reliability of delivery, loss of flexibility and political issues have all been valid reasons for deciding against it.

Those reasons, in some cases, have inhibited the development of a further understanding of the potential benefits of offshore sourcing because they have been presented as obstacles early in the decision-making process at many companies. In other cases, however, companies have succeeded in taking advantage of the opportunity to source offshore without assuming unacceptable risks.

There are still other reasons why companies do not explore offshore sourcing. Many defense contractors and subcontractors, for instance, believe that using parts made abroad is downright illegal. It is not. Depending on the specific country, processes and products involved, sourcing can be and is used as a tool to achieve competitive advantage. In fact, international discussions under way may require a certain percentage of defense products to be imported from such friendly regions as the Caribbean.

Central American and Caribbean countries recently have become important sources of supply to American electronic manufacturers because the region, in many cases, offers greater advantages than other offshore locations, including the Far East. Westinghouse Corp., for example, just announced plans to build a $5 million plant in the Dominican Republic for printed circuit boards.

Westinghouse joins a host of other U.S. electronics companies — Apple Computer Corp., Digital Equipment Corp., GTE Corp., Honeywell Inc., Motorola Inc. and Unysis among others — that have set up operations in the Caribbean. The region is even attracting investment by Japanese and Korean electronics companies as a manufacturing base for their U.S. marketing efforts. Notably, Matsushita Electric has started producing some of its U.S.-bound stereos and radio pagers in Puerto Rico.

Most of the activity is the result of the Caribbean Basin Initiative (CBI), which created a one-way free trade area for companies. Electronics products made in the area have duty-free access to the U.S. market for 12 years. The CBI program, which became effective on January 1, 1984, creates opportunities for direct involvement by U.S. companies in joint ventures, subcontract manufacturing, technology licensing and other types of offshore operations.

Most Caribbean basin countries offer foreign investment incentives such as income tax and customs duty exemptions, factory rentals at concessionary rates, labor training programs and guaranteed repatriation of profits. Many countries have developed foreign trade zones where companies are guaranteed extra freedom from foreign exchange controls and import restrictions.

Twin plants

The Generalized System of Preferences (GSP) and the tariff schedules 806.3 and 807 administered by the U.S. Department of Commerce provide other types of production sharing arrangements. Both provisions allow for duty-free treatment on the value added offshore to products of U.S. origin. They have popularized the twin plant concept used by many manufacturers such as Westinghouse.

Under the concept, product design and engineering activities take place in the United States. The manufacture of primary components is done in low wage countries such as the Dominican Republic or Malaysia. And the high technology finishing operations, such as assembly and testing formerly done in the United States, are now performed in countries having a high-tech infrastructure and a larger composition of skilled workers like Puerto Rico or Singapore.

Other countries, such as India for example, actively seek electronics companies in particular. Recently, the country has modified its incentive programs and has begun rebuilding its infrastructure to achieve this objective. DEC and Honeywell are examples of companies taking advantage of opportunities in India.

Another popular choice is Mexico, especially the border region. The proximity to the United States offers significant advantages — more than enough to offset the higher cost of doing business in Mexico than other foreign countries. RCA Corp., now part of General Electric Co., has a large manufacturing operation in the region, employing 5,700 workers. General Instrument Corp., TDK and Weston Instruments also run border plants.

Helpful steps

Developing a sound sourcing strategy is difficult. It involves the analysis and determination of many controllable and uncontrollable factors that span international boundaries and change over time. It requires an understanding of the interaction between a multitude of measurable variables, an objective assessment of the risks involved and the appropriate balance of those risks with the long-term strategy of the company. All too often, electronic companies typically reach sourcing decisions that do not consider all the most important options.

An effective process for devising the proper sourcing strategy, one that has been used effectively by several electronics companies, links business strategy to product-sourcing decisions. It is a highly structured process involving six action-oriented steps:

- **Step 1.** Review the current sourcing strategy.
- **Step 2.** Identify feasible sourcing options.
- **Step 3.** Perform global scenario analysis.
- **Step 4.** Perform qualitative country-

U.S. companies lean on global sources of supply

U.S. electronics industry imports ($ millions)

Products	1981	1982	1983	1984	1985
Communications	$840	$1,434	$2,586	$3,696	$4,154
Consumer electronics	3,581	3,765	8,356	11,765	14,338
Electron tubes	218	137	276	342	397
Electronic parts	2,045	2,242	3,769	5,339	5,860
Industrial electronics	2,913	3,106	7,111	11,512	12,896
Solid state products	763	1,035	4,980	7,657	5,713
Total	**$10,360**	**$11,719**	**$27,078**	**$40,311**	**$43,358**

Source: Electronic Industries Association

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by-country analysis.

- **Step 5.** Evaluate the long-term impact of possible sourcing decisions. (To be taken concurrently with Step 4.)
- **Step 6.** Develop a strategic plan.

The six-step process presents, in a generic form, a comprehensive approach to developing an efficient product sourcing strategy. The appropriate methodology to be used by each company will depend on the actual situation and limitations of the particular company. Each step may be modified to a company's specific needs.

Who in a company should devise such a strategy? It depends on the size and structure of the individual organization. Product- and market-driven organizations, by their nature, have a larger number of managerial levels making decisions involving multifunctional parameters. In these organizations, the business unit becomes the focal point to evaluate the net effect of sourcing decisions on the final product's cost by considering its impact in all the functional areas. In functionally driven organizations, sourcing decisions are usually made at the corporate level to achieve the same level of integration.

Once a sourcing strategy has been developed, two major activities are still required. It must be implemented. And it must be reevaluated continually to keep current.

Also remember that a global sourcing strategy is only the starting point to the development of a new set of competitive opportunities created by the changes it makes to the current industry structure and the impact it has on the formation, elimination, and displacement of entire industries.

Global sourcing is critcal to the success of many companies in the electronics industry. Together with marketing, technology and control, it is a key factor for achieving competitive success. Marketing and technology develop the right product; sourcing and manufacturing provide it at the right price; and control delivers it to the market at the right time.

If a company does not have a global sourcing strategy and its competitors do, or if it incorrectly implements one, the consequences can be disastrous. If, however, the strategy is properly defined and executed on a timely basis, the potential for achieving competitive success is tremendous. ☐

Bequillard is a senior associate at Theodore Barry & Associates, a management consulting firm based in Cambridge, Mass.

LEADTIME INDEX

Electronic component leadtimes

Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average	Last month's average
TRANSFORMERS								
Toroidal	0	25	59	8	8	0	8.8	8.1
Pot-Core	0	13	63	12	12	0	10.5	8.2
Laminate (power)	0	28	61	5	6	0	8.0	7.7
CONNECTORS								
Military panel	11	22	45	11	11	0	8.8	9.6
Flat/Cable	23	41	23	9	0	4	5.9	3.9
Multipin circular	0	21	43	36	0	0	9.6	8.9
PC	11	45	33	11	0	0	5.7	6.0
RF/Coaxial	17	50	17	16	0	0	5.4	4.4
Socket	23	53	12	12	0	0	4.4	4.7
Terminal blocks	12	47	29	12	0	0	5.6	4.2
Edge card	9	41	32	14	4	0	7.0	5.5
Subminiature	18	41	23	12	6	0	6.4	6.5
Rack & panel	10	50	20	20	0	0	6.2	5.8
Power	8	23	54	15	0	0	7.4	5.7
PRINTED CIRCUIT BOARDS								
Single-sided	0	65	35	0	0	0	4.8	5.4
Double-sided	0	30	70	0	0	0	6.5	4.3
Multilayer	0	18	65	13	4	0	8.9	7.2
Prototype	0	79	16	5	0	0	4.4	2.7
RESISTORS								
Carbon film	37	33	19	11	0	0	4.2	3.1
Carbon composition	35	38	19	8	0	0	3.9	5.4
Metal film	33	29	29	9	0	0	4.5	3.8
Metal oxide	25	33	42	0	0	0	4.3	5.6
Wirewound	43	43	14	0	0	0	2.4	6.4
Potentiometers	19	33	33	15	0	0	5.9	6.6
Networks	19	29	38	14	0	0	6.1	5.6
FUSES	43	43	14	0	0	0	2.4	3.0
SWITCHES								
Pushbutton	26	44	17	13	0	0	4.7	4.9
Rotary	10	45	35	10	0	0	5.7	5.3
Rocker	26	42	21	11	0	0	4.6	5.0
Thumbwheel	20	40	27	13	0	0	5.4	7.5
Snap action	36	46	9	9	0	0	3.5	4.5
Momentary	37	27	27	9	0	0	4.4	5.4
Dual in-line	20	60	10	10	0	0	4.2	5.5
WIRE AND CABLE								
Coaxial	50	44	6	0	0	0	1.8	3.6
Flat ribbon	59	32	9	0	0	0	1.7	3.6
Multiconductor	47	35	12	6	0	0	2.9	4.0
Hookup	58	38	4	0	0	0	1.5	1.7
Wire wrap	67	33	0	0	0	0	1.0	2.8
Power cords	20	48	28	4	0	0	4.3	4.4
Other	33	17	33	17	0	0	5.8	3.2
POWER SUPPLIES								
Switching	10	37	37	16	0	0	6.5	9.0
Linear	17	50	25	8	0	0	4.8	8.1
CIRCUIT BREAKERS	22	28	39	11	0	0	5.7	6.6
HEAT SINKS	35	35	24	6	0	0	3.9	4.3

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Average	Last month's average
RELAYS								
General purpose	32	21	37	10	0	0	5.2	6.5
PC board	10	32	32	21	5	0	8.1	8.3
Dry reed	8	33	42	17	0	0	6.9	10.0
Mercury	0	29	57	14	0	0	7.6	11.0
Solid state	8	31	31	23	7	0	8.9	8.2
DISCRETE SEMICONDUCTORS								
Diode	39	18	39	0	0	4	4.8	4.5
Zener	39	9	35	17	0	0	5.7	4.9
Thyristor	27	7	53	13	0	0	6.5	6.4
Small signal transistor	35	20	30	15	0	0	5.3	7.1
FET, MOS	13	20	53	7	7	0	7.6	7.8
Power, bipolar	15	39	46	0	0	0	4.8	4.5
INTEGRATED CIRCUITS, DIGITAL								
CMOS	23	31	27	15	4	0	6.4	7.6
TTL	26	22	39	9	0	4	6.5	4.7
LS	32	18	39	7	4	0	5.7	5.0
INTEGRATED CIRCUITS, LINEAR								
Communication/circuit	25	12	50	13	0	0	6.3	7.9
OP amplifier	10	37	37	16	0	0	6.5	8.0
Voltage regulator	14	33	34	19	0	0	6.6	6.8
MEMORY CIRCUITS								
RAM 16k	14	57	29	0	0	0	4.0	8.4
RAM 64k	17	50	33	0	0	0	4.2	6.7
RAM 256k	18	46	27	19	0	0	5.0	7.7
ROM/PROM	0	55	45	0	0	0	5.3	8.0
EPROM	14	41	27	14	0	4	6.9	7.3
EEPROM	8	31	46	8	0	7	8.2	8.3
DISPLAYS								
Panel meters	9	46	27	18	0	0	6.4	5.7
Fluorescent	0	29	43	14	14	0	10.1	10.0
Incandescent	0	75	25	0	0	0	4.3	9.3
LED	9	54	23	14	0	0	5.6	5.9
Liquid crystal	0	39	46	15	0	0	7.2	8.7
MICROPROCESSOR ICs								
8-bit	20	53	20	7	0	0	4.2	7.3
16-bit	20	70	10	0	0	0	2.9	8.2
FUNCTION PACKAGES								
Amplifier	0	63	37	0	0	0	4.9	8.3
Converter, analog to digital	0	39	38	15	8	0	8.6	10.8
Converter, digital to analog	0	40	40	10	10	0	8.5	10.7
LINE FILTERS	0	50	38	12	0	0	6.4	7.5
CAPACITORS								
Ceramic	23	41	21	15	0	0	5.2	4.9
Ceramic monolithic	20	40	25	15	0	0	5.5	5.4
Ceramic disc	27	31	27	15	0	0	5.5	5.6
Film	21	24	45	10	0	0	5.9	6.7
Electrolytic	19	37	18	26	0	0	6.6	6.3
Tantalum	15	37	26	22	0	0	6.6	7.2
INDUCTORS	8	38	54	0	0	0	5.5	6.6

Source: *Electronics Purchasing* magazine's survey of buyers

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FEBRUARY 15, 1987

Electronic Business

Factory automation at Westinghouse and IBM

Parallel processing: Strategies for an expanding market

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Tandem's Treybig: Fault-free visions of an expanding niche

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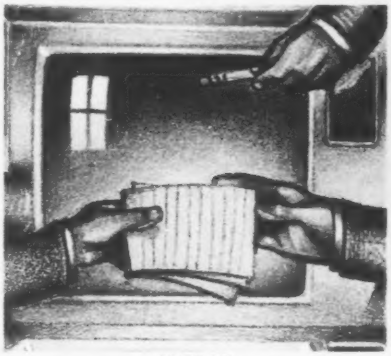

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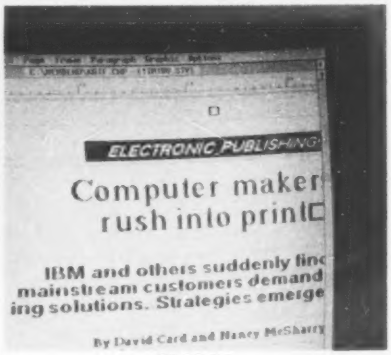

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Computer maker
rush into print

IBM and others suddenly fin
mainstream customers demand
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By David Card and Nancy McSharry

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BPA ABP

Offshore manufacturing, trade protection depress production

But last quarter's sales of computers and office equipment pointed up. Brazil gets a reprieve

Name a country where the market for computers and office equipment grew 35% in 1985 (a tough year), and which restricts imports of foreign-made equipment. No, it's not Japan (where local production last year grew in dollars but not in yen). It's Brazil. With its market protected from competition, this country's local production of computer equipment doubled between 1984 and 1986 while production in the United States barely grew 1% during the same period.

As Clayton Yeutter, the U.S. trade representative, demonstrated last Dec. 30 by imposing sanctions against European farm products, the United States is taking an increasingly critical view of — and more militant actions against — countries which restrict imports to protect their own production from competition while they enjoy free, sometimes even privileged, access to the U.S. market. In the case of the computer industry, production costs and prices are still cheaper in the U.S. than almost anywhere else except the Far East. Hit by the double impact of migration of production from these shores across the Pacific Ocean and the closure of markets such as Brazil, U.S. computer manufacturers produced fewer dollars worth of equipment in 1986 than in 1985. For the first time in history, the U.S. production of computers and office equipment (SIC 357) declined in 1986, by 3%, after a sluggish annual growth of 4% in 1985. Cahners Economics forecasts 4% growth for this year.

Along with the trade sanctions he issued against Europe, Yeutter also extended until June 30 a negotiation period, due to have expired at the end of 1986, with the Brazilian government regarding U.S. investment and software copyrights in that country. U.S. companies have complained that an unhelpful bureaucracy and unclear administrative rules hinder their investment in local manufacturing and the protection and sales of their software in Brazil. The Brazilian government, which had clarified somewhat other issues on computer imports, needed more time.

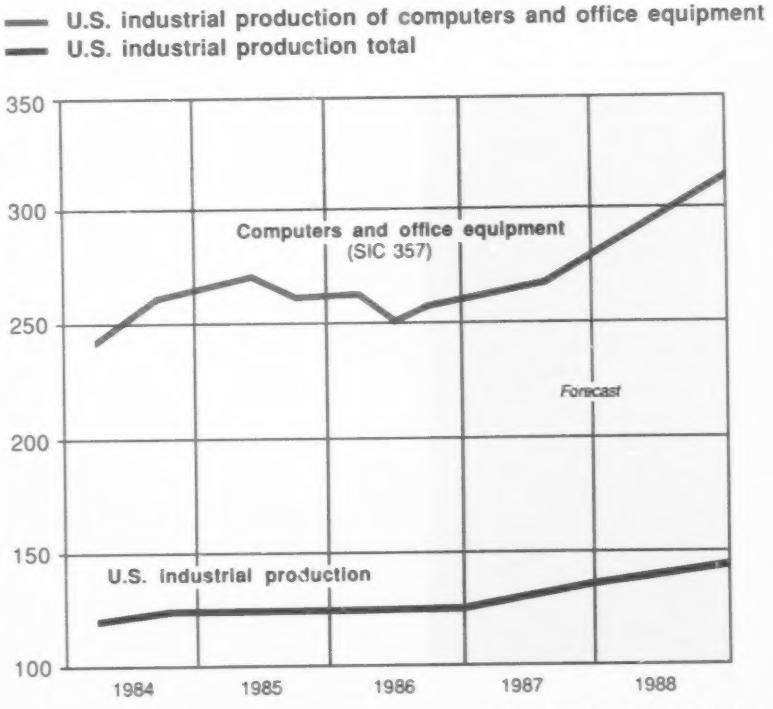
Not that the Brazilian market is that large. It only amounted to $2.3 billion for systems and $1.5 billion for software in 1985, about one-tenth the size of the U.S. market. But 1985 was also the year when domestic production of both hardware and software in Brazil edged out the value of imports (most of them of U.S. origin). Spurred by demand from the local market, the slight edge is expected to have turned last year into a gap, in Brazil's favor. And, with a population larger than Japan's, plus the access it has to most of its South American neighbors, Brazil is just too important a market for the U.S. government to ignore and too strategic a base for U.S. computer manufacturers to abandon.

As for the U.S. market, sales turned up a bit in the last quarter of 1986. National Advanced Systems, the computer division of National Semiconductor Corp., provided most of the gains that made its sales grow 30% over 1985's last quarter. NAS computers, however, did not contribute to the U.S. industrial production for SIC 357 because they are made by Hitachi in Japan.

ALBERTO SOCOLOVSKY

Computers and office equipment

Industrial production indexes, 1977 = 100



Historical data: Federal Reserve Board
Forecast: Cahners Economics

Electrical machinery

Manufacturers of electrical and electronic machinery operated at 71.4% of available capacity in the third quarter of 1986, up slightly from the 71.2% rate in the previous quarter. This was the first increase since summer 1984 and signaled that the industry finally has begun to pull out of its prolonged slump. Early reports for the fourth quarter show that operating levels continue to gradually improve. The uptrend is expected to be sustained throughout the current year, carried upward by a modest rebound in most nondefense segments of electronics. Factory operating rates are expected to reach 74% to 75% by the end of 1987 and 80% by late 1988.

Instruments

In the third quarter of 1986, instrument manufacturers utilized 80.1% of plant capacity, a very slight reduction from the second quarter's 80.5% rate. Not surprisingly, production volumes also decreased during the quarter (by about 0.1%). Manufacturers are likely to cut back further during early 1987, but a pickup in U.S. business investment should help to reverse the trend late this year. The operating rate, which should have finished 1986 at just under 79%, is expected to dip to about 77% by mid-1987 but should get back to 78% to 79% by year's end. An overall increase of about 5% is expected to follow over the course of 1988.

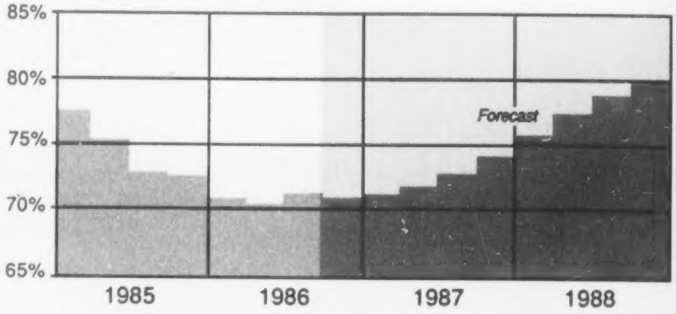
Aerospace

The rate of plant utilization in the aerospace equipment industries reached 88.3% in the third quarter of 1986, an increase of more than a full percentage point over the level in the second quarter. Year-end reports point to a fourth-quarter decrease of about the same magnitude. Although defense procurement authority has been squeezed by recent budget cutbacks, backlogs for military/aerospace equipment remain sufficiently high to sustain a healthy rate of production activity for at least another year. Plant operating rates are expected to level off at an 89% to 90% range through mid-1987, but will then begin to decline gradually. By the end of 1988, the rate should be down to nearly 80%.

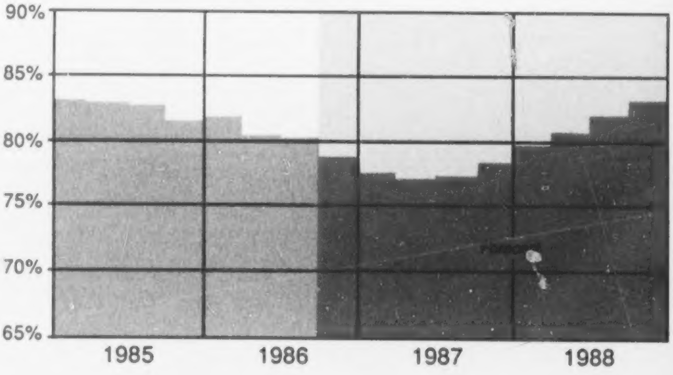
Plant utilization

Average percentage of capacity utilized per quarter

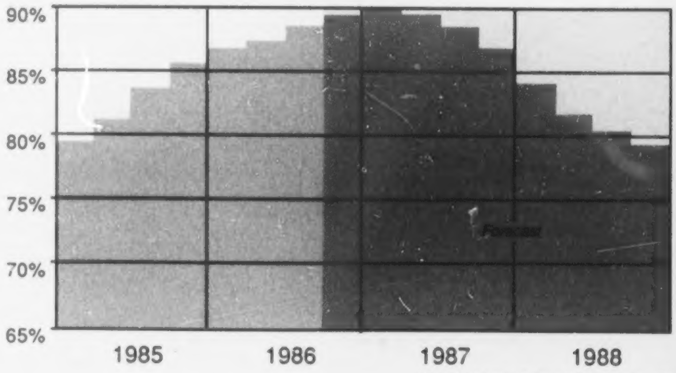
Electrical machinery (SIC 36)



Instruments (SIC 38)



Aerospace (SIC 37)



Historical data: Federal Reserve Board
Forecast: Cahners Economics

Electronic components and accessories

Producer prices for electronic components rose 1.0% in the third quarter of 1986, their sharpest increase in 18 months. Price increases in product areas such as semiconductors and connectors were responsible for the jump. Most other types of components showed little evidence of upward pressure. Prices are expected to show another moderate uptick in the fourth quarter, bringing the yearly increase to 2%. This compares with a 2.4% rise in 1985. Accelerating market growth in 1987 and 1988 are expected to cause inflationary pressures to heat up once again. Prices should rise 3% this year and 3.4% in 1988.

Linear ICs

Third-quarter producer prices of linear integrated circuits (ICs) fell 0.8%, or at a 3.2% annualized rate of decline. This was the eighth consecutive quarter in which prices experienced downward pressures. After edging lower in the fourth quarter, prices are expected to firm or perhaps even rise slightly during 1987. This trend will stem from recent improvements in market conditions; orders jumped nearly 35% last year and shipments about 19% (several times faster than the growth rate for total U.S. market semiconductor shipments). Prices are expected to climb about 2% in 1987 and 3.7% more in 1988, just enough to counterbalance last year's 5.2% decrease.

Digital bipolar ICs

Producer prices for digital bipolar ICs were relatively stable during the third quarter of 1986, decreasing merely 0.7% compared with the prior quarter. This was only a brief pause in the price escalation which started in mid-1985. Preliminary estimates for the fourth quarter point to renewed upward pressures, with prices forecast to jump about 2.4%. For 1986 as a whole, prices will average 4.4% ahead of the previous year's level. If orders show the expected improvement in 1987, then inflationary pressures will continue to build. Prices are projected to increase 9.6% this year and about 6.5% in 1988.

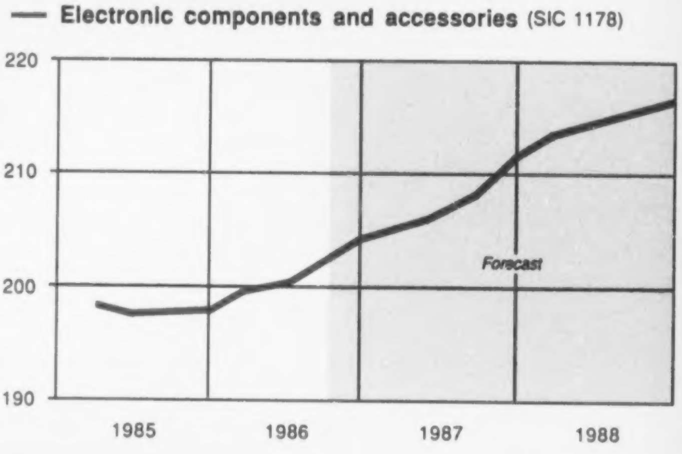
Digital MOS ICs

Prices of digital metal-oxide semiconductor (MOS) ICs tumbled 3% in last year's third quarter (an 11.3% annualized rate of decrease). This reversed the second quarter's equally strong move upward, bringing prices about back to first-quarter levels. Annually, prices are expected to post a decrease of more than 10% compared with 1985. U.S. market orders for the entire January to September period were more than double the year-earlier level, a brisk growth pace which suggests that prices could begin to escalate soon. Prices are currently expected to climb about 5.5% this year and 2.4% more next year.

Producer price indexes

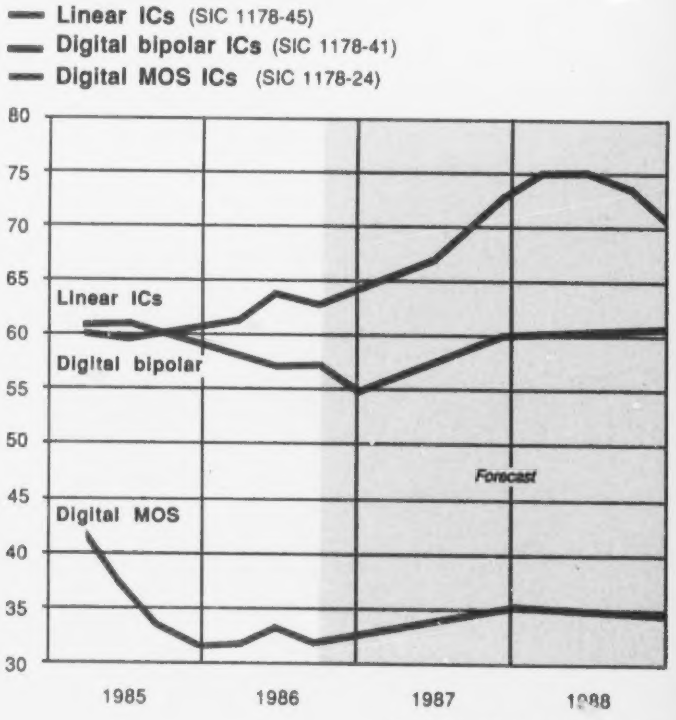
Electronic components

December 1967 = 100, quarterly averages



Integrated circuits

December 1974 = 100, quarterly averages



Historical data: Bureau of Labor Statistics
Forecast: Cahners Economics

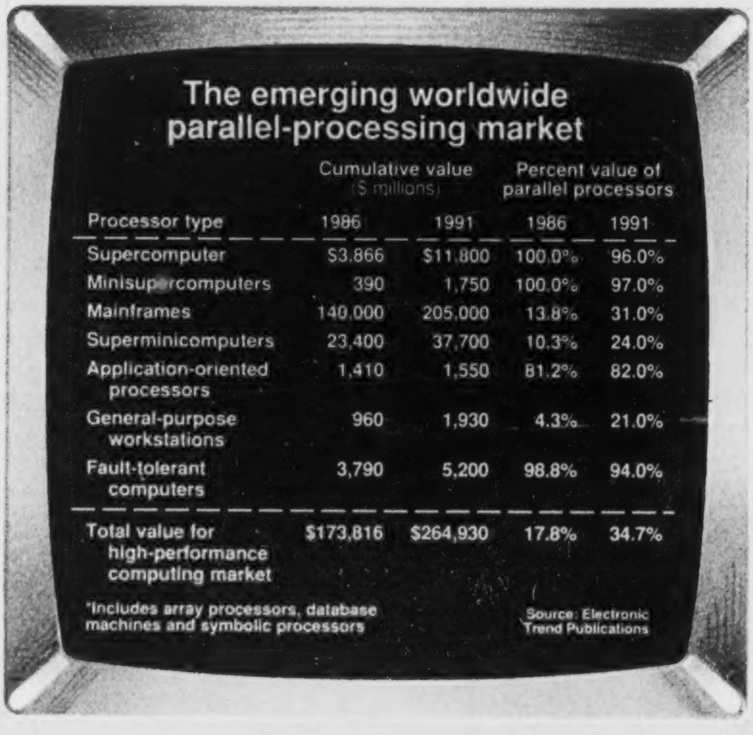
Parallel processing: When computers swap information internally

Interest in parallel processing is running high. But so far it's only a $31 million market

Most computers today process data in a serial fashion, somewhat akin to a stream of cars heading one by one down a single-lane tunnel. In the future, however, most computers may be parallel processsors, machines designed to handle data concurrently — more like a multiple-lane tunnel with numerous off ramps.

But for the moment only two or three computer vendors are actually racing ahead with commercial parallel processor designs. The vast majority of companies are still keeping their parallel processor projects under wraps, hidden from view in private research and development (R&D) labs. The reason they are reluctant to enter the commercial market is simple, says Hambrecht & Quist Inc. analyst Jeffrey Canin: "There are too many contenders in the market. And there are lots more stumbling blocks in the way to developing clean parallel-processing [software] code."

"Many vendors are saying their machines offer parallel processing," adds Bruce Hadburg, a consultant with San Jose, California-based Electronic Trend Publications. Hadburg considers "true" parallel machines to be those which allow parallel execution of instructions within a single processor, permit parallel execution of instructions between multiple processors and/or link multiple processors (with or without shared memory). Based on this definition, the 1986 worldwide market for parallel processors reached approximately 47,300 units (19.9% of the total 237,894 high-performance processors shipped last year), worth $30.9 million, Hadburg says.



The emerging worldwide parallel-processing market

Processor type	Cumulative value ($ millions) 1986	Cumulative value ($ millions) 1991	Percent value of parallel processors 1986	Percent value of parallel processors 1991
Supercomputer	$3.866	$11,800	100.0%	96.0%
Minisupercomputers	390	1,750	100.0%	97.0%
Mainframes	140,000	205,000	13.8%	31.0%
Superminicomputers	23,400	37,700	10.3%	24.0%
Application-oriented processors	1,410	1,550	81.2%	82.0%
General-purpose workstations	960	1,930	4.3%	21.0%
Fault-tolerant computers	3,790	5,200	98.8%	94.0%
Total value for high-performance computing market	$173,816	$264,930	17.8%	34.7%

*Includes array processors, database machines and symbolic processors

Source: Electronic Trend Publications

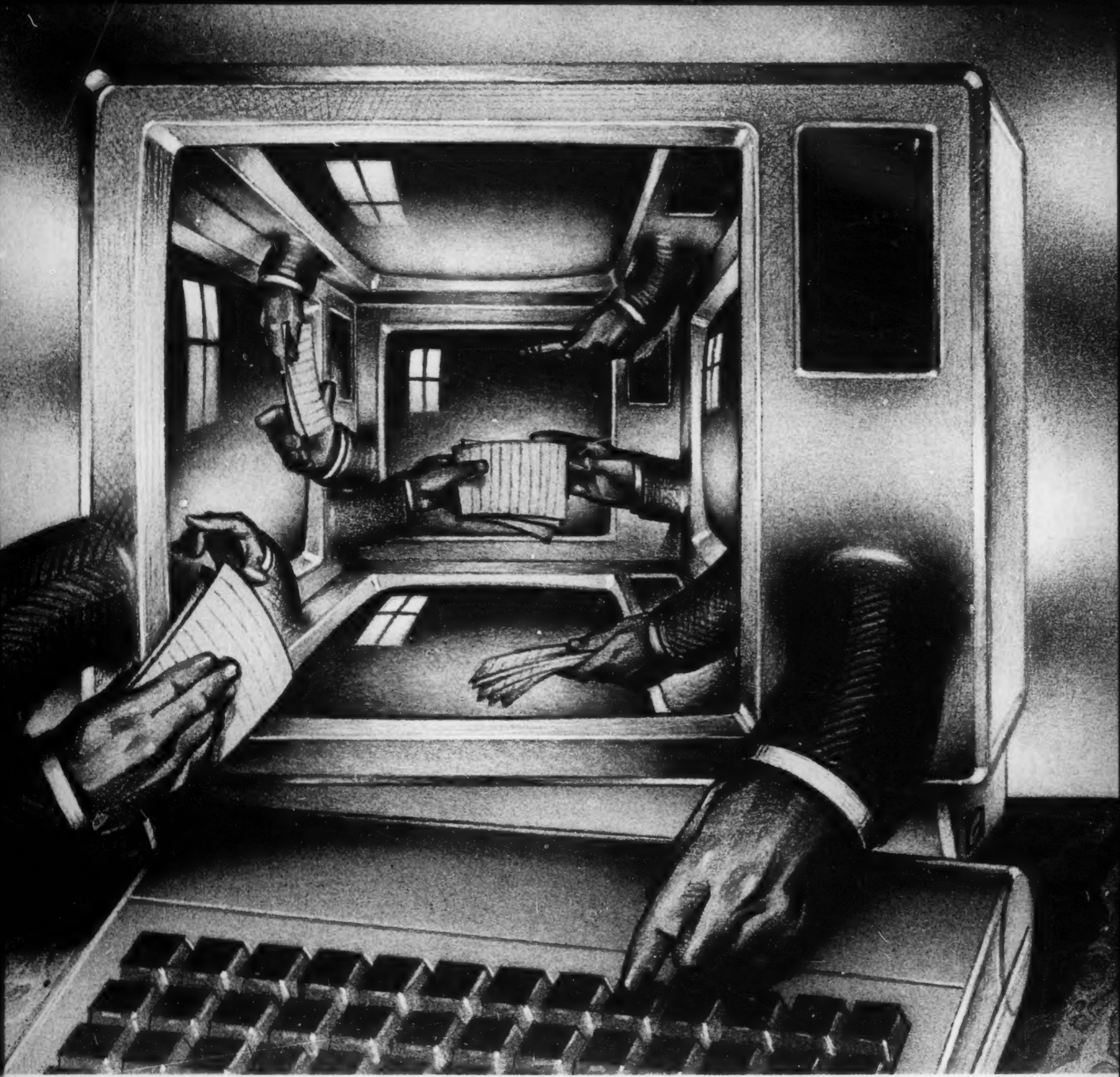
Greg Couch

Interest in this new type of computer architecture by potential users is not at all surprising. With two closely related technologies — fault tolerance and multiprocessing — parallel processing makes for vastly increased computing speeds. But whereas fault-tolerant and multiprocessor machines work their magic by channeling different programs to different processors, parallel machines enable single programs to be partitioned among different processors.

But curiously, there is not a whole lot that is unique about the hardware itself used in parallel processing. In fact, most of the existing generation of machines are built around off-the-shelf microprocessors, such as the Intel Corp. 80X86, Motorola 68000 and the National Semiconductor 32032. Rather, parallel processing is largely the result of innovative, operating systems-level software, a large proportion of which is based on some derivative of Unix. And because many problems in mathematics, science and engineering are well suited to this type of partitioning, the first parallel processors have found solid acceptance in university R&D labs, among electrical and electronics companies, and in large-scale defense projects.

In the lab

Meanwhile, quite a few parallel-processing projects remain sequestered in the R&D labs of their manufacturers. IBM, for example, is known to have several ongoing parallel developments. Its most famous are the Yorktown Heights, N.Y., reduced instruction set computer (RISC) parallel machine which has received an enormous amount of press but may be years away from delivery; and its San Jose-based Amoeba project, consisting of several 43XX superminis linked together in a parallel configuration.



Greg Couch

At the same time, IBM's archrival, AT&T, has also made its first commercial move into parallel processing. Late last year, AT&T announced that it won a Defense Advanced Research Projects Agency (DARPA) contract in conjunction with New York City start-up Fifth Generation Computer Corp. for parallel computers that can recognize speech and images and handle other complex, pattern-matching tasks. The contract is expected to be worth $7.7 million to AT&T over the next three years.

Among the large uniprocessor manufacturers, Digital Equipment Corp. is considered to be the furthest along toward introducing a commercial parallel processor. Hambrecht & Quist's Canin says rumors are circulating that the Maynard, Mass., minicomputer maker could introduce a parallel machine within two years. "If any vendor has the credibility to make it big in this area, it's DEC," Canin claims.

For its part, DEC refuses to confirm or deny reports that at the end of 1986 it shelved two parallel research projects, one with Lawrence Livermore Labs, and another with Carnegie-Mellon University. (One, allegedly code-named Parallel Processing Architecture, or PPA, was said to support 32 to 128 linked MicroVAX II nodes. The other, called Andromeda, reportedly bundled 64 MicroVAX IIs into a single cabinet.) Instead, a DEC spokesperson maintains that DEC's VAX 8300 and 8800 superminis can handle limited dual-processor parallel processing. And, since "all DEC's products are evolutionary, you can expect us to continue to do work in parallel processing," said the DEC source.

The parallel pack

Most big-name computer vendors, however, would be unable to introduce parallel versions of their lines (even if they existed) because they would obsolete most of their existing computers which still have three- to five-year life cycles ahead of them, industry watchers say. In addition, these companies could not afford to alienate their customers by rendering their proprietary applications software incompatible with the new, often Unix-based operating-system software required for parallel processors.

As a result, the top parallel-processing vendors tend to be single-product start-ups or relatively new supermini/

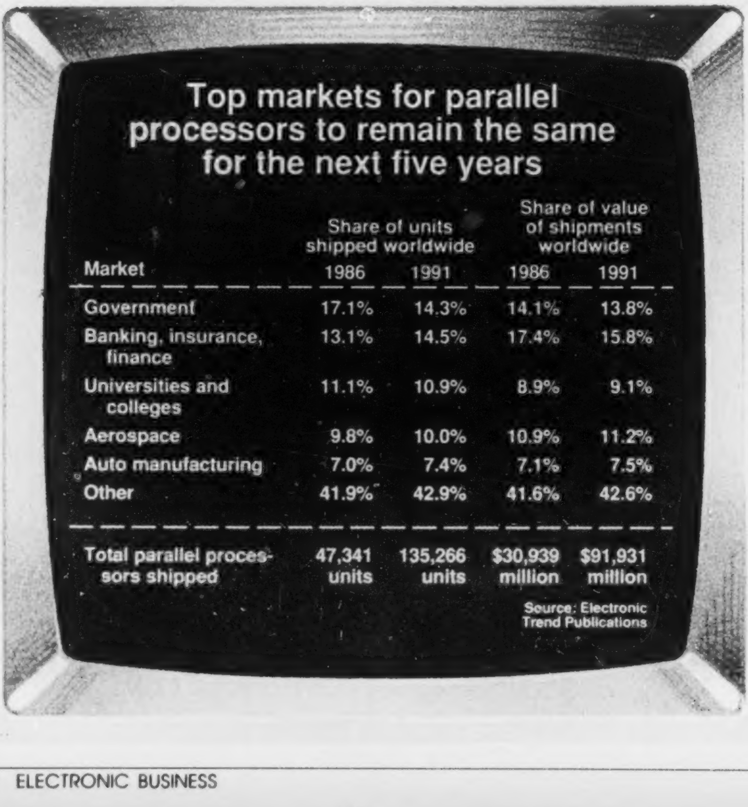
minisupercomputer makers. The recognized No. 1 vendor (in terms of installations to date) is Sequent Computer Systems Inc. of Beaverton, Ore., with more than 150 systems installed (although not all of these systems are used for parallel processing). Minisupercomputer vendor Alliant Computer of Littleton, Mass., with 55 installations as of the end of last year (when it filed its initial public offering), is No. 2.

Behind these two are several moderately successful vendors, including Culler Scientific, Intel Corp., N-Cube and Parallel Computers. The rest of the parallel pack is comprised of lots of small firms, each of which claims a handful of installations, and several more established vendors which are known to be having trouble finalizing, selling or maintaining their products. Among the latter are manufacturers like Aurora, Colorado's Denelcor Inc. — seen by many as the granddaddy of parallel processing — which filed under Chapter 11 bankruptcy protection in 1986; and minisuper maker Flexible Computer Corp. of Dallas, which was suffering from a severe cash flow problem at the end of last year.

What separates the sure-fire successes from not-so-sure ones (as well as from the outright failures)? "Some machines aren't suitable for anything but parallel processing," says Hambrecht & Quist's Canin. "I'm skeptical for their outlook — at least in the near term." Adds Electronic Trend's Hadburg: "Right now, almost everybody's going after the few same markets. That's where the action is."

The top parallel-processing vendors tend to be single-product start-ups or relatively new supermini/minisupercomputer makers

Traditionally, the biggest market for parallel processing has been the academic/scientific arena. Thinking Machines Corp., maker of the Connection Machine, had by year-end 1986 sold only six machines: one to DARPA, two to the Massachusetts Institute of Technology (MIT), one to Yale University and two to Perkin-Elmer Corp.'s MRJ government contracting subsidiary. (A typical Connection Machine consists of 16,000 processors and sells for $1 million.) But the start-up appears pleased with its progress. Even Thinking Machines director of marketing, James Bailey, emphasizes the company product's academic/scientific orientation and benefits, rather than any commercial ones. "The purpose of parallel processing is to gain efficiency and fit the problem better," he says.



Top markets for parallel processors to remain the same for the next five years

Market	Share of units shipped worldwide		Share of value of shipments worldwide	
	1986	1991	1986	1991
Government	17.1%	14.3%	14.1%	13.8%
Banking, insurance, finance	13.1%	14.5%	17.4%	15.8%
Universities and colleges	11.1%	10.9%	8.9%	9.1%
Aerospace	9.8%	10.0%	10.9%	11.2%
Auto manufacturing	7.0%	7.4%	7.1%	7.5%
Other	41.9%	42.9%	41.6%	42.6%
Total parallel processors shipped	47,341 units	135,266 units	$30,939 million	$91,931 million

Source: Electronic Trend Publications

At the opposite end of the spectrum is Sequent, which already has signed up a handful of key original equipment manufacturers (OEMs), such as Siemens and Teradyne Inc. and more than 130 independent software vendors to help the company make inroads into the commercial world. In December, Sequent closed its third consecutive profitable quarter and ended the year at roughly $20 million, according to Michael Simon, vice president for marketing.

The company currently sells a compatible line of machines known as the Balance series, all of which are based on National Semiconductor's 32032. It is slated to debut a new parallel processor line — which may or may not be based on National's chips — sometime in early 1987. Market watchers such as Canin claim that relatively few of Sequent's machines are used for parallel processing. Canin says that most customers are buying the Sequent machine because it has better price/performance ratios than other superminis, notably DEC's VAX line. Not true, says Simon. He maintains that close to 90% of Sequent's machines are being used, at least part of the time, for parallel-processing applications.

"Our goal at Sequent is taking the [parallel-processing] technology beyond the scientific community," Simon says. "We are the first example of a truly parallel machine that's commercially focused."

Meanwhile the rest of the parallel processor community is searching for niches somewhere between the academic and the business worlds, hoping to avoid the shakeout so many industry watchers are predicting. But for at least the next five years, few, if any, new applications areas are expected to open up. Instead, says Hadburg, the growth markets for parallel machines will remain the same: banking, finance and insurance; government; universities and colleges; aerospace; and automobile manufacturing.

MARY JO FOLEY

One-stop solutions for multivendor problems

Equipment manufacturers are trespassing on independent service organizations' third-party maintenance territory

An increasing number of equipment manufacturers are being lured into the business of maintaining other vendors' equipment. The bait is the growing U.S. third-party maintenance market, a $1.56 billion U.S. industry that is expected to hit $3.26 billion in sales by 1991, according to Input, a market research firm in Mountain View, Calif.

Customer demand for "one-stop solutions" to problems caused by a multivendor environment is fueling the market.

At one multivendor location — Rockwell International Corp.'s avionics research and engineering division in Lakewood, Calif., — the decision to go with third-party maintenance was the result of a process of elimination, says Peter Kubischta, supervisor of Rockwell's software avionics integration lab. His unit uses equipment from 10 different vendors. Training and equipping an in-house maintenance staff "would be more expensive than going outside," Kubischta says. Another option: signing individual service contracts with each of the 10 equipment manufacturers, would not only be costly from an administrative standpoint, it would also lead to "finger-pointing" problems, he adds. In the end, Rockwell decided on a third-party maintenance solution and signed on with Harris Corp.'s Customer Support Division, based in Dallas.

Manufacturers are expanding their service menus to include equipment from other vendors

Harris was attracted to third-party maintenance by both customer demand and revenue opportunities, says Carleton L. Smith, vice president of the company's Customer Support Division. "The price of hardware is dropping, how do you make more money?" asks Smith. One solution, he suggests, is to expand service offerings.

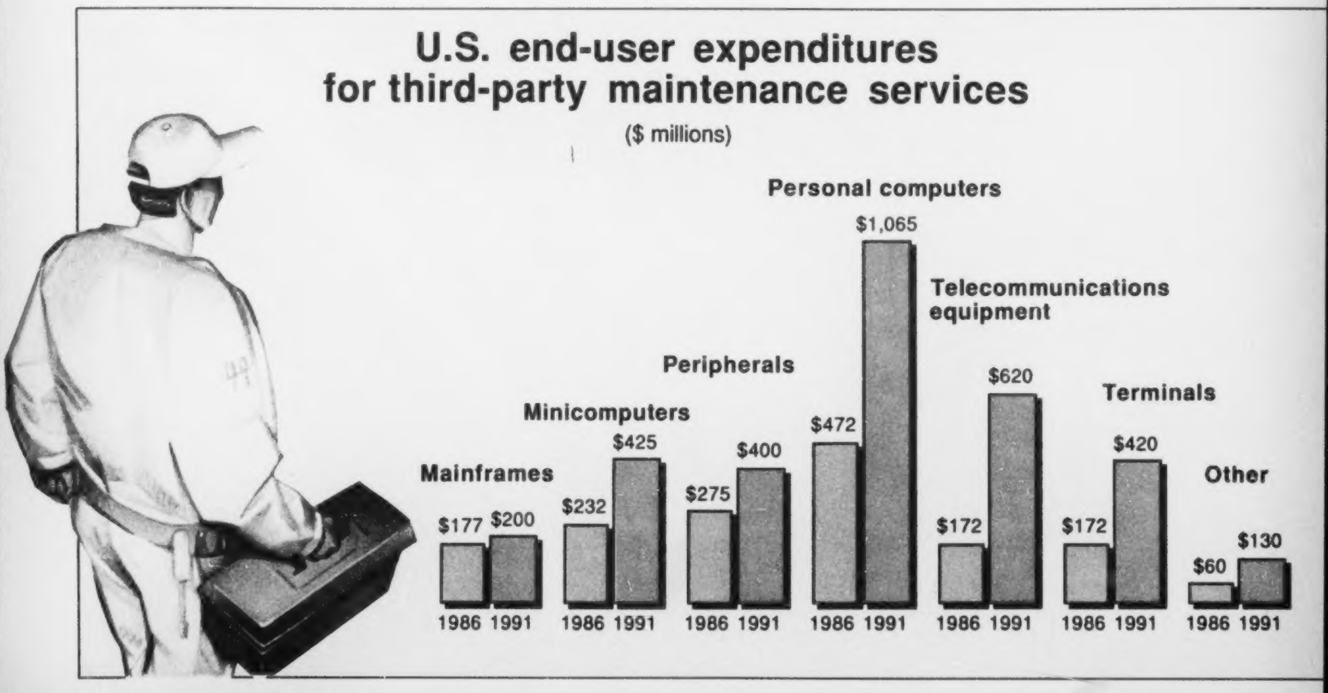
But, as the quality of hardware improves, many field service engineers are left in the position of "the old, lonely Maytag repairman, whom no one calls," says Rick Brusuelas, manager for the customer service program at Input. Hence, in order to get the most out of a nationwide team of field service engineers, manufacturers are expanding their service menus to include equipment from other vendors.

Trouble for ISOs

This trend will cause a slowdown for many of the traditional independent service organizations (ISOs), such as Bell Atlantic Corp.'s subsidiary Sorbus, TRW Inc. and Intelogic Trace. In the future, the ISO market revenue is forecast to grow at an average annual growth rate of only 8% — from $1.255 billion in 1985 to $1.85 billion in 1991, according to Richard C. Munn, president of The Ledgeway Group, Lexington, Mass., a research and consulting firm specializing in the service industry. Meanwhile, service by equipment makers is expected to grow at a much faster rate.

Munn divides the equipment makers' market into two segments. In the segment that Munn refers to as the "two and one-half party service" — where companies such as DEC and

Greg Couch



U.S. end-user expenditures for third-party maintenance services

($ millions)

IBM will service other vendors' equipment only in existing DEC or IBM environments — revenue is forecast to grow from $75 million in 1985 to $405 million by 1990, reflecting a 40% average annual growth rate. Munn separates two and one-half party service companies because, he says, there is a fundamental difference in providing additional service to an existing or already captive customer versus going outside that realm and building a new customer clientele based only on service. Within the major vendor segment — where equipment manufacturers such as Harris Corp., Honeywell Inc., NCR Corp., Sperry Corp. (now a part of Unisys Corp.) and Xerox Corp. offer third-party service at any site — revenue is forecast to grow from $150 million in 1985 to $300 million by 1990, reflecting an average annual rate of 15%, according to Munn.

Leading the pack in two and one-half party service is Digital Equipment Corp., which has been offering its DECompatible service since 1983. Today, on a region by region basis, DEC services some 500 non-DEC products. However, "the whole purpose [in servicing non-DEC equipment] is customer satisfaction. Revenue is not the driving force," insists Daniel Loesel, business manager at DEC's U.S. headquarters for vendor equipment services in Westborough, Mass. Loesel estimates that revenue from servicing non-DEC equipment represents less than 10% of all of DEC's service revenue. In the last fiscal year, ended June 30, service accounted for about a quarter of the company's total $7.5 billion in sales, according to analysts' estimates.

Even Big Blue, which traditionally limited its service exclusively to IBM equipment, is starting to service non-IBM equipment, albeit on a very limited basis. Over the past year, the Armonk, N.Y., giant has begun to service a list of more than 80 peripherals — such as modems, printers and plug-in cards — that are attached to IBM PCs.

Even Big Blue, which traditionally limited its service to IBM equipment, is starting to service non-IBM equipment, albeit on a limited basis

For those manufacturers daring to venture outside their own customer base, however, taking the plunge to service other vendors' equipment is far more complex than most entrants realize, says William J. Herbert, president of consulting firm Coordinated Service Inc., in Littleton, Mass. "Just because you have a couple of thousand talented service people spread across the country who understand your own equipment, that doesn't guarantee success [in third-party maintenance]," says Herbert.

In order to increase one's chances of success, Rebecca Segal, analyst at research firm International Data Corp. in Framingham, Mass., advises equipment makers to "stick to what you know, or find a niche that's profitable."

Taking the plunge

In fact, when Harris first took on third-party maintenance in September of 1985, the business plan called for a focus on specific products. Since that time, however, "we have come to realize that you have to look at particular segments where you can offer something special, as opposed to trying to be everything to everyone," says Smith. Now, Harris is concentrating on several niche markets, including aerospace manufacturers and small government operations such as county municipalities — two customer segments that tend to have a vast mix of suppliers, Smith notes. Another area Harris is working on involves signing service agreements with a number of Japanese original equipment manufacturers (OEMs), which, according to Smith, "have good products and good sales, but are not noted for their service." Out of the $75 million generated by Harris' Customer Support Division last year, $3 million came from third-party service, and Smith expects the third-party revenue to double this year.

One vertical area arousing a lot of interest these days is telecommunications equipment, says Brusuelas of Input, "mainly because the [telecommunications equipment] manufacturers themselves are not responding." Service revenue for telecommunications equipment is expected to reach $620 million by 1991, reflecting a 29% average annual growth rate, according to a recent Input report. Other product segments that promise healthy growth rates for service revenue include: the terminals segment, which is forecast to grow from $172 million in 1986 to $420 million by 1991; personal computers, which will grow from $472 million to $1.065 billion; and minicomputers, which is expected to grow from $232 million to $425 million.

The biggest opportunity in the future could be the servicing of software. The "next big stepping stone," says Segal of IDC, will be in software support. Software is becoming increasingly intertwined with hardware, she points out, yet software support frequently requires a whole different set of skills. As a result, Segal says, it is difficult for third-party maintenance vendors to attract and hold the right people to provide such service.

Other areas of potential growth within the service industry, include: assisting customers with product selection; consulting with customers as they plan their networks; and providing educational services such as training. In the segment for large systems — mainframes and supercomputers — where service revenue is expected to grow from $4.1 billion in 1986 to $5.8 billion by 1991, the hardware share of revenue will decrease from 81% to 63%, while software revenue will grow from 11% to 23%. The remainder of 1991 revenue will come from professional services such as consulting and planning, at 10%, and education and training, at 4%, according to Input.

CAROL SUBY

Tandem: Growth in a niche that never fails

James Treybig does not mind being called a niche player these days. His strategy has reaped nearly $1 billion

By Anne Knowles

Being traditionally thought of as a niche market player isn't the worst thing in the world — especially when your niche protects you from the market giants while widening at a strong rate. Tandem Computers Inc., the Cupertino, Calif., maker of fault tolerant computers — systems designed to fail rarely, if ever — has continued to enjoy a protected niche status throughout the computer industry's upturns and downturns. The company's unique systems design, based on multiple processors and a proprietary operating system, sets the 10-year-old company apart, pegging it as a supplier to the relatively small fault tolerant market. But Tandem's success has caused it to start looking beyond its safe haven and has caused other companies to covet Tandem's business.

Consider Tandem and the business it is in. Larger computer manufacturers have shied away from the fault tolerant market, in part, because of the inherent difficulties of designing fail-proof architectures. Meanwhile, Tandem has emerged from a near thorough shakeout in the fault tolerant market, in the process rising to the top of the heap and capturing over 80% market share. Most important, the reliability provided by such systems has become increasingly attractive to more customers in markets outside fault tolerance. Add that up and you have a $768 million company for the fiscal year ending Sept. 30, 1986, and a firm now considered a major force in the computer industry. Says Kimball Brown, an industry analyst with Dataquest Inc., a market research firm in San Jose, Calif.: "The three companies that are the biggest threat to IBM are Digital Equipment Corp., NEC Corp. and Tandem."

AT A GLANCE

Tandem Computers Inc.
Cupertino, Calif.

	FISCAL YEAR COMPARISON		
	1985	1986	Change
Sales ($ thousands)	$624,138	$767,793	+23.0%
Net income ($ thousands)	$34,374	$63,766	+85.5%
Net income/sales	5.5%	8.3%	–
Cost of sales/sales	38.5%	32.3%	–
R&D/sales	11.5%	11.3%	–
Marketing, G&A/sales	42.0%	42.6%	–
Capital expenditures/sales	10.8%	8.5%	–
Number of employees	5,494	5,719	+4.1%
Sales per employee	$113,604	$134,253	+18.2%
Net income per employee	$6,257	$11,150	+78.2%
Current ratio	4.44	3.87	–
Debt/equity ratio	0.01	0.01	–

Fiscal year ending September 30,

Source: Dow Jones News/Retrieval

No small praise for a niche market player. In fact, says James G. Treybig, Tandem's president and chief executive, he no longer minds Tandem being tagged a niche player. "I used to not like that word, niche," says Treybig. "But I don't think it's negative. We're choosing niches. By choosing where we fight and win we can be quite a big, profitable company."

Today Tandem is trying to do all of those things. And the company's so-called niches are more numerous now than they have ever been. Tandem is targeting vertical markets — from transportation to retail point-of-sales — that fall under a larger market umbrella called on-line transaction processing (OLTP). While traditional fault tolerant applications — those applications where system failure can be disastrous — represented only a $738 million market in 1985, OLTP — defined as the execution of transactions in real time — reached an estimated $20.3 billion last year, according to Dataquest. By 1990, projects Dataquest, OLTP will be a $35 billion business, accounting for about 70% of all new computer sales.

Because of this, larger computer makers are finding the OLTP market too alluring to ignore. And, as Treybig says, Tandem is fighting. IBM already has about 54% of the OLTP market because of its preeminent position in the mainframe market. (Most OLTP applications are supported by a host computer, which, as a general rule, is a mainframe containing a database. A front-end processor provides fault tolerance, safeguarding data in case any

HEEEEEEERE's JIMMY: Tandem president James Treybig regularly takes to the in-house company network to discuss strategy

Liane Enkelis

other part of the system fails. At the end of the network, depending upon the application, are various kinds of terminals, such as personal computers or cash registers, which can access or alter the database in real time.)

But, says George Weiss, an analyst with Gartner Group Inc., in Stamford, Conn., "OLTP is moving toward distributed processing and departmental systems, away from mainframes." Because of that, IBM has fortified its OLTP offering through an original equipment manufacturer (OEM) agreement with Stratus Computer Corp., of Marlboro, Mass., for a low-end fault tolerant system that IBM calls the System/88. And Stratus, bolstered by IBM's stamp of approval, and despite the fact it is one-sixth the size of Tandem, has proven to be the most viable fault tolerant alternative to Tandem. In particular, Stratus' strengths — low-end systems and the East Coast sales territory — have been Tandem's weaknesses.

In more specific markets Tandem is treading on the toes of other major manufacturers. In retail, which currently represents 5% of Tandem's revenue, NCR Corp. has been the historical favorite due to its point-of-sale terminals. In April, NCR shored up its product line with the announcement of its 9800 series mainframes incorporating fault tolerant features.

Digital Equipment is expected to announce enhancements to VMS, its operating system, that will make the company a more competitive threat in OLTP. But DEC's systems, says the Gartner Group's Weiss, are not optimized for OLTP applications. "DEC has a long road on this one," says Weiss. Despite that, DEC dominates manufacturing, a market that accounted for 21% of Tandem's 1986 sales. Concludes Treybig: "In all the industries where there are engineers we have DEC. And in all the industries where there aren't engineers we have IBM."

According to Treybig, however, Tandem is winning in those markets that it is zeroing in on. Tandem equipment is used in 19 stock exchanges. In telephony, where Treybig says Tandem is safer because of the lack of IBM penetration, the company supplies processors to Pacific Bell, Southwestern Bell and US Sprint. Tandem computers automate manufacturing at Apple Computer, Audi and Hughes Aircraft Co.

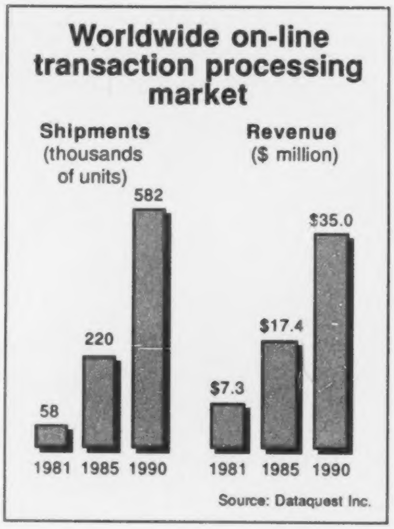
"In point-of-sale, we have literally every major bank. We have big retailers like Target and [J.C.] Penney. We have people in the supermarket area like Safeway and Kentucky Fried Chicken. We have every major petroleum company in the U.S., except one. And that one is a Penney's customer, and Penney is a Tandem customer. That's a niche," says Treybig. "And we won it all."

Low-end lure

Tandem hasn't won it all yet. But the company is systematically addressing gaps in both its marketing and product line that have hindered it before. Treybig is the first to admit the mistakes made in the past. "We didn't do a good job on third parties. We didn't build products in the lower price range and that was a strategic mistake. We didn't do a good job, for example, on major account support. Five years ago we were lucky to sell a customer one system," says Treybig.

The remedy, says Treybig, is to concentrate on sets of solutions rather than individual products. "I think the importance of solutions is that the customer buys one and then they can buy a second one much sooner. And a third and a fourth," says Treybig. And each time, adds Treybig, it becomes, "easier to convince them to buy it."

To soldify its solution sell, Tandem is broadening its product line. Already, says Gartner Group's Weiss, "Tandem has the strength at the high-end." Tandem's TXP, with an average selling price of $450,000, accounts for approximately 75% of the company's revenue. Tandem's VLX, announced last April, has a processing range of 40 to 160 transactions per second (TPS), a price tag starting at $1 million and currently represents about 20% of the company's revenue. It is also the first Tandem system that encroaches on IBM's mainframe turf. Another high-end processor, code-named Cyclone, which analysts project will be 50% faster than the VLX, is expected next year.


Worldwide on-line transaction processing market

Source: Dataquest Inc.

In the midrange, Tandem rejuvenated its product line with the EXT-10 and EXT-25, announced last August. Says Treybig: "Our success this year is going to come from the VLX, EXT-10 and EXT-25." But from a new product point of view, Treybig says, 1987 will focus on the low-end.

Treybig says that the announcements will involve entry-level systems, application generators and database software. Specifically, most industry analysts believe Tandem will announce three low-end systems designed to compete more effectively, on a price basis, with DEC, Stratus and other rivals. By midyear, Tandem should unveil its first system based on complementary metal-oxide semiconductor (CMOS) technology. Jonathan Fram, an analyst with Bear, Sterns & Company Inc. in New York City, contends the system may also be Tandem's first uniprocessor configuration. A single processor computer, says Fram, would not be capable of fault tolerance but would act as a node on a network.

Tandem will also announce its second computer which will run a standard operating system. Already the company sells PC AT-compatible machines, which it buys from Tandon Corp. that run MS-DOS. The company is buying Altos Computer Systems' 3068 machine, based on Motorola Inc.'s 68020, 32-bit chip and the Unix operating system. Industry observers disagree over whether the machine will contain single or multiple processors. But these observers believe the system is designed to enable Tandem to bid on contracts which require Unix.

Asked if the company will ever offer Unix on a proprietary Tandem computer, Treybig says, "We're going to offer more than the Altos." Asked if offering Unix, a standard system offered by many vendors, could turn Tandem hardware into a mere commodity, Treybig contends, "The reason people like Unix is the perceived ease of programming. But application

Liane Enkelis

MICHAEL BATEMAN, vice president for third-party marketing and **GERALD PETERSON,** vice president for marketing, manage Tandem's thrust into the OEM and VAR market generators are going to replace that. When that point gets here you don't care that the underlying hardware is microprocessor based running Unix or whether its gate arrays running our operating system."

Tandem's hardware design, today, uses multiple processors with their own memory. Because of that, the systems are easily expandable. Additional processors can be added onto a system without the performance degradation created when more processors try to access the same memory.

Tandem's proprietary operating system, Guardian, manages the flow of data between the processors' memories. It is a message-based system. The importance of this is that if processor A, for example, needs data located at processor B's memory, the system will send a message requesting that the information be transferred to processor A. To users on a network, says Fram, all data looks local. The net result, says Dataquest's Brown, is the only truly distributed processing system on the market.

In addition, Tandem's Multilan product, announced last November, enables users to connect to any local area network (LAN) supported by IBM's Network Basic Input/Output System (NETBIOS). "Tandem's made great strides in LAN interfaces," says Tony Fernandez, a staff manager with Pacific Bell. Pacific Bell uses Tandem's NonStop II and TXP systems and Tandem's Expand networking software.

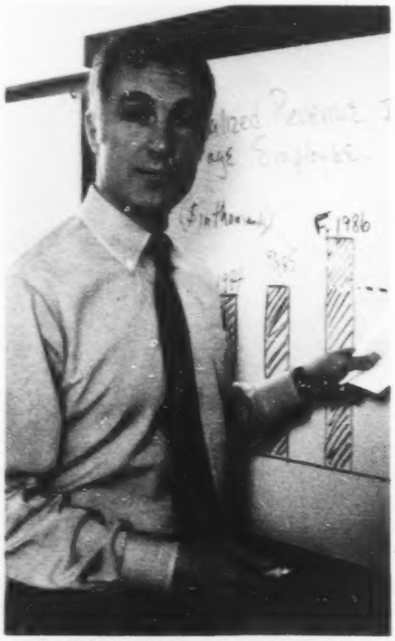
But he is dissatisfied with Tandem's datacommunications products and, recently, with the company's software support. "We're not getting any," says Fernandez. He would also like to beta test Tandem's Teseract product, the company's as yet unannounced database system. But Tandem, says Fernandez, wants Pacific Bell to buy a VLX to do the testing on. "It's power politics," says Fernandez. "We've always had a very good relationship;" but, he says he is now having problems with Tandem that he hasn't had in the three years since Pacific Bell first purchased its Tandem system. "That happens with change," Fernandez says.

Competitive alliances

Things are changing at Tandem. In the past, Tandem has depended primarily on direct sales to price-insensitive *Fortune* 1000 customers. Today, OEMs and value-added resellers (VARs) still only represent 7% of Tandem's sales. But with the thrust into the low-end, Tandem marketing is changing its look.

The process began with a reorganization of the company's third-party marketing division in October 1985. Today, it is called the Alliance program. Under this umbrella falls all of Tandem's OEMs, software developers and VARs. This program is managed by Michael K. Bateman, vice president for third-party marketing.

The Alliance program is broken into five categories. Solution implementers, says Bateman, include consultants like Arthur Young & Co. which will install computer-integrated manufacturing (CIM) turnkey systems for Tandem customers. Tandem writes its own systems software, such as Encompass, the company's database product; and independent software vendors (ISVs) develop programming tools for Tandem systems. Tandem makes the sale, says Bateman, and splits the revenue with the ISV.



DAVID RYNNE, Tandem's chief financial officer: "We restored our margins to very acceptable levels in 1986"

Liane Enkelis

Tandem has had considerable success signing up software houses which write application packages. The company's list of third-party software writers has grown from 35 in 1983 to 250 today. Bateman estimates that one-half to two-thirds of Tandem's new customers are influenced by a third party.

Two third-party software houses, under the direction of Susan L. Hailey, Tandem's retail industry manager, clinched the deal on Ross Stores, according to Gerald L. Peterson, Tandem's vice president for marketing. Signorum Inc., Fremont, Calif., and LeRoux, Pitts & Associates Inc., Clearwater, Fla., jointly developed StoreLink, a fault tolerant retail point-of-sale control system. Ross Stores was able to tie together sales and inventory at 146 stores, each with an average of 10 NCR cash registers, using the software. In the process, Ross replaced six NCR minicomputers, used at night as batch processors, with a Tandem TXP. "NCR didn't have a solution," says Peter Hart, vice president for information systems with Ross. "We needed a vendor to provide a single solution."

Tandem has about 10 classical OEM relationships. System Integrators Inc. in Sacramento, Calif., is Tandem's largest OEM. SI sells turnkey publishing systems, built around all of Tandem's processors except the VLX, to such customers as *The Washington Post*, *The Los Angeles Times* and *The Chicago Tribune*. According to Stephen Nilan, SI's director of marketing, Tandem systems were chosen because of their modular expandability, reliabilty and communications capabilities. (SI uses Tandem's networking software called Expand.) Even though DEC products were evaluated by SI, Nilan says that the company didn't want, "just another me-too product."

But SI has had its problem with Tandem. The VAR would like to expand its customer base to smaller publishers and is looking forward to low-end products Tandem is expected to announce this year. "We've had a problem moving downward," says Nilan. "And our margins are being squeezed." In addition, says Nilan, SI thinks the price of the TXP, which hasn't been cut since the introduction of Tandem's high-end VLX, should better reflect market conditions. But, adds Nilan, "we're so far down the road with Tandem we can't think of changing."

Tandem is hoping the same isn't true of DEC's VARs. The company's most recent, and industrious, project under Alliance has been the courting of VARs that are dissatisfied with DEC's discount schedules. In September of last year, Tandem contacted over 1,100 DEC VARs. A telemarketing campaign was carried out by a consultant in October and a teleconference was broadcast to 26 cities. Treybig does not expect to see concrete results from the program until mid-1987. But he says he would be content with three or four VARs on the East Coast — where DEC has a stronghold and Tandem has a hole. According to Philip A. Stack, regional Alliance program manager for the Northeast, the company was at the contract stage with that many eastern VARs in December.

Cutting costs

Through all this change, Tandem has certainly been profitable. In Tandem's latest fiscal year, ended Sept. 30, revenue rose 23% while net income climbed 86%, to $63.8 million. Tandem's operating margins, at 13.8%, are the highest they have been in five years. Operating income spiraled 112%, to $105.9 million. Tandem's pretax profit margins stood at 13.8%, better than industry wunderkind DEC. And net income as a percent of sales jumped to 8.3% from 5.5% in 1985.

But, it has been a few years since Tandem's income statement looked so good. In the early 1980s, the company was predicting it would be a billion-dollar company by mid-decade. At the time, Tandem had the growth rates to substantiate such claims. In 1980, Tandem raised its net income 117% on a revenue increase of 95%. The following year revenue rose 91% and net income soared 148%. But, by 1984, an economic snafu hit the industry and Tandem's revenue growth slowed to a respectable 17%. But net income plunged 20%.

"We built expenses faster than we should have, given the decrease in growth rates," explains Treybig. In response, like many other computer manufacturers, Tandem implemented cost cutting measures that started in manufacturing and led to stiffer personnel policies, including short-term hiring and salary freezes.

About three years ago, says David J. Rynne, Tandem's chief financial officer, the company put in place various "nuts and bolts" improvements to expedite the production process. Included was a revamping of manufacturing protocols that cut back on overtime. During the slower first two months of a quarter, says Rynne, manufacturing prebuilds subassemblies needed for the hectic last month of the period. Stricter quality-control procedures were imposed on suppliers. In the end, says Rynne, reducing the cost of production resulted in a drop in the cost of inventory.

"But manufacturing is only half the story as it appears on the P&L [profit and loss]," statement, says Rynne. The other half, says Rynne, is savings from newer technologies incorporated in newer Tandem products. Tandem's VLX, for example, is based on very large scale integration (VLSI) chips developed jointly between Tandem and Motorola Inc. In addition, the MCA2800 ALS, the processor designed by the two companies, has now become a standard product offering at Motorola, which has additionally reduced the cost and guaranteed volume production for Tandem.

Tandem's VLX is based on VLSI chips developed between Tandem and Motorola

Bear Sterns' Fram believes the VLX has a preexisting upgrade built into the first model. The VLX, which uses both emitter coupled logic (ECL) and transistor-transistor logic (TTL), has the same 83 nanosecond clock cycle as Tandem's previous high-end offering, the TXP. What Fram and other analysts expect is a complete ECL implementation of the VLX — which will use the same chassis, have better performance and a higher price tag, and all without increasing Tandem's manufacturing costs.

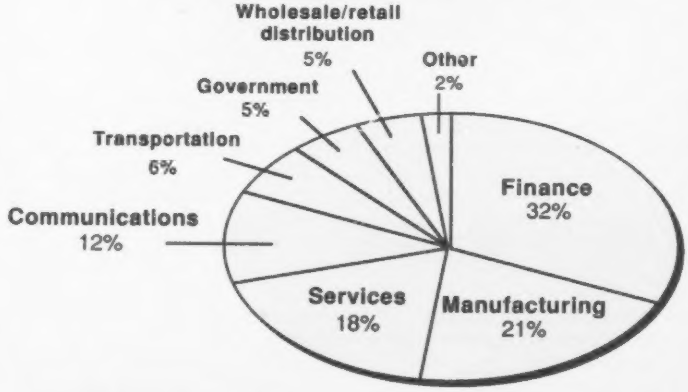
The end result, for Tandem, has been an improvement of gross profit margins, from 61.5% in 1985 to 67.7% in 1986. But those benefits will be flattening out this year and, in fact, says Treybig, Tandem has to raise its inventory level above the $64 million recorded at year end. "We restored our margins to very acceptable levels in 1986," says Rynne. "We don't aspire to improve them."

But this year Tandem is changing its accounting practices in regard to selling, general, and administrative (SG&A) costs because of an order from the Securities Exchange Commission. The result will be a slight drop in both gross profit margins and SG&A expenses. SG&A costs, at 42.6% of sales, have always been above the norm due to the customer hand-holding needed to sell Tandem systems and because of the high cost of competing against IBM.

Tandem's 1986 balance sheet was equally impressive. The company ended the year with virtually no long-term debt — $4.5 million — and a lot of cash — $239.8 million. According to Rynne, Tandem hopes to buy five or six buildings it now leases in Cupertino. In addition, the company may make investments in, or acquisitions of, companies developing technology that is pertinent to Tandem's business. Already Tandem has equity investments in numerous companies. With Pacific Bell, Tandem has a 24.5% stake in Integrated Technology Inc. of Plano, Texas, for telecommunications network systems. And in March, Tandem invested in Triplex, a maker of fault tolerant programmable logic controllers.

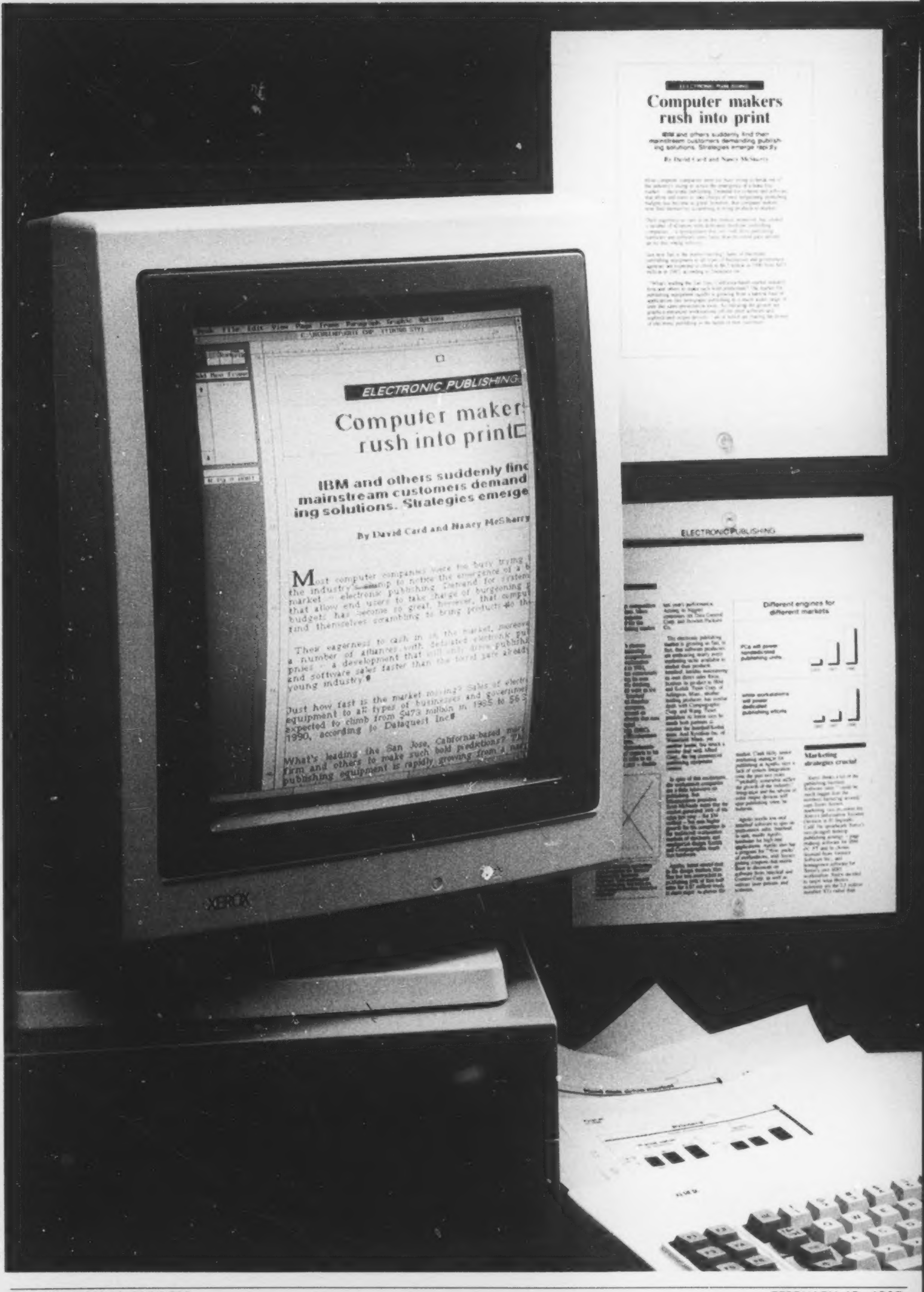
And finally, says Rynne, Tandem can use the money to finance further growth. ☐

Tandem's fiscal 1986 revenue by market segment



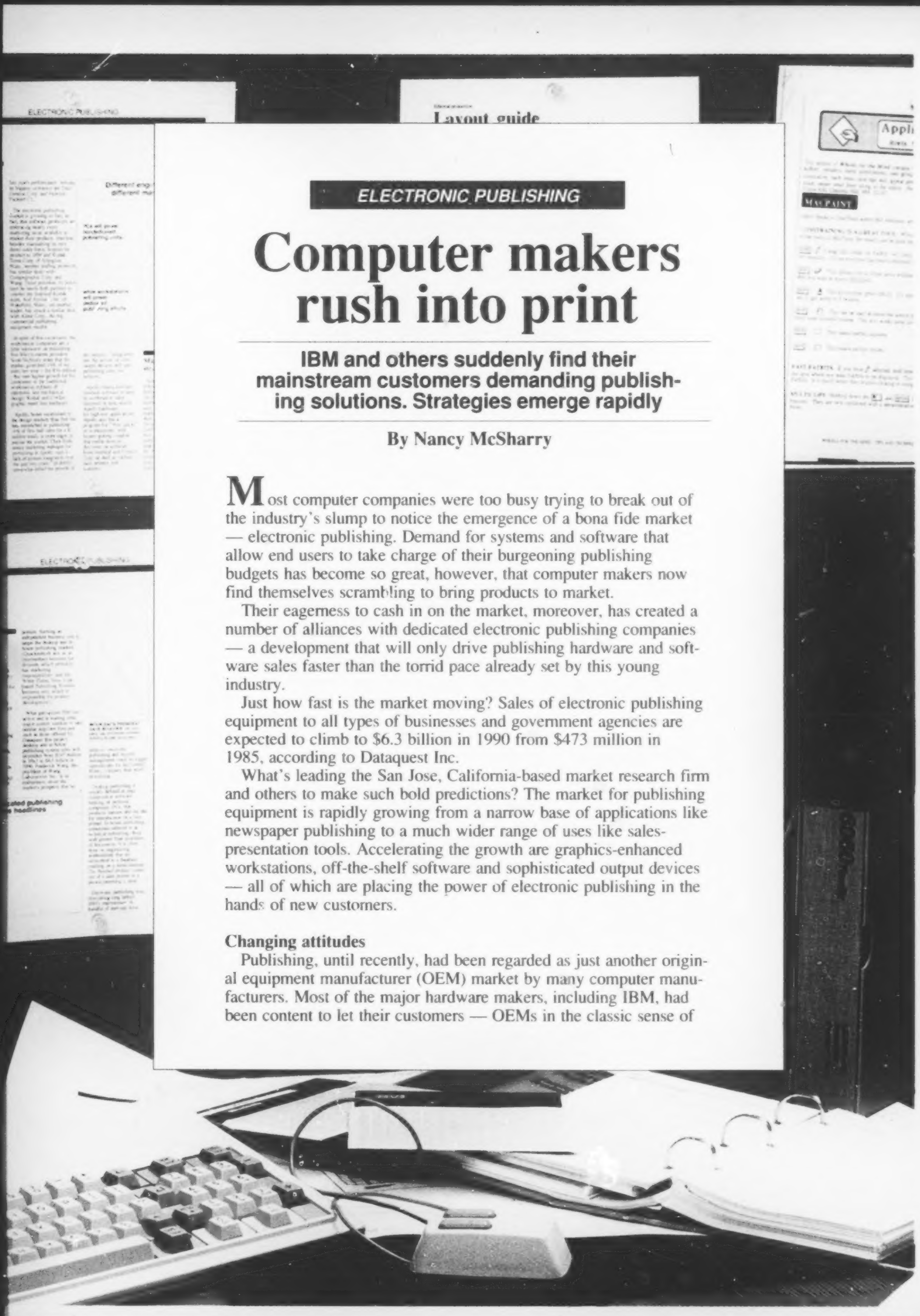
*Percentages do not add up to 100% due to rounding

Source: Tandem Computers Inc.



ELECTRONIC PUBLISHING
Computer makers rush into print
IBM and others suddenly find their mainstream customers demanding publishing solutions. Strategies emerge rapidly
By David Card and Nancy McSharry
ELECTRONIC PUBLISHING
Different engines for different markets
Marketing strategies crucial
XEROX

Dilip Chauhan



ELECTRONIC PUBLISHING

Computer makers rush into print

IBM and others suddenly find their mainstream customers demanding publishing solutions. Strategies emerge rapidly

By Nancy McSharry

Most computer companies were too busy trying to break out of the industry's slump to notice the emergence of a bona fide market — electronic publishing. Demand for systems and software that allow end users to take charge of their burgeoning publishing budgets has become so great, however, that computer makers now find themselves scrambling to bring products to market.

Their eagerness to cash in on the market, moreover, has created a number of alliances with dedicated electronic publishing companies — a development that will only drive publishing hardware and software sales faster than the torrid pace already set by this young industry.

Just how fast is the market moving? Sales of electronic publishing equipment to all types of businesses and government agencies are expected to climb to $6.3 billion in 1990 from $473 million in 1985, according to Dataquest Inc.

What's leading the San Jose, California-based market research firm and others to make such bold predictions? The market for publishing equipment is rapidly growing from a narrow base of applications like newspaper publishing to a much wider range of uses like sales-presentation tools. Accelerating the growth are graphics-enhanced workstations, off-the-shelf software and sophisticated output devices — all of which are placing the power of electronic publishing in the hands of new customers.

Changing attitudes

Publishing, until recently, had been regarded as just another original equipment manufacturer (OEM) market by many computer manufacturers. Most of the major hardware makers, including IBM, had been content to let their customers — OEMs in the classic sense of the term — develop the software and add the peripherals needed to sell publishing systems. They let their OEM customers — the hardcore print suppliers like Allied-Signal Inc.'s Linotype division, Compugraphic Corp. and Eastman Kodak Co.'s Atex division — worry about point sizes and the like. After all, the market for commercial printing systems, typesetters and electronic service bureaus was only projected to reach $700 million by 1990.

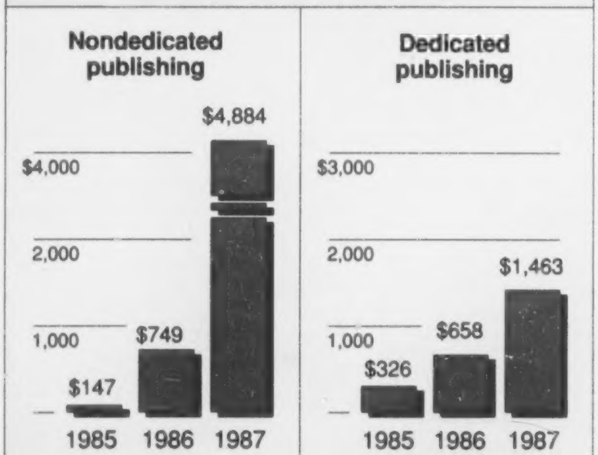
"IBM has not moved aggressively in the last decade" in directly pursuing publishing, acknowledges Merry Quackenbush, director of IBM's Valhalla, New York-based Media Industry and Publishing Systems Division, which is part of Big Blue's Information Systems Group. The company last summer took a more aggressive posture, forming an independent business unit to target the desktop and in-house publishing markets. (Quackenbush acts as an intermediary between her division, which primarily has marketing responsibilities, and the White Plains, New York-based Publishing Systems business unit, which is responsible for product development.)

What galvanized IBM into action and is leading other major system vendors to take similar steps are forecasts such as those offered by Dataquest that project desktop and in-house publishing system sales will skyrocket from $147 million in 1985 to $4.9 billion in 1990. Frederick Wang, the president of Wang Laboratories Inc., is so enthusiastic about the market's prospects that he believes electronic publishing and records management could be bigger opportunities for his Lowell, Mass., company than word processing.

Desktop publishing is usually defined as page composition software running on personal computers (PCs) that produces memos and the like for reproduction on a laser printer. In-house publishing, sometimes referred to as technical publishing, deals with greater final quantities of documents. It is often done on engineering workstations that are networked to a database residing on a minicomputer. The finished product comes out of a laser printer or a phototypesetting system.

INTERLEAF'S PRESIDENT DAVE BOUCHER: His company has consciously avoided building its own computers

Nondedicated publishing grabs headlines



Source: Dataquest Inc.

Electronic publishing was flourishing long before IBM's *imprimatur*. A handful of start-ups have written publishing software for workstations to go after the in-plant and technical publishing market. And Apple Computer Inc. has reaped the fruits of other software start-ups' labor in the desktop arena. Now the new guys are cutting deals with the commercial publishing equipment vendors, as Kodak and Xerox Corp. have started selling systems from their base in printers and photocopiers.

Demand for chips

The opportunities in electronic publishing are not limited to major systems vendors and software houses. Semiconductor producers, board makers, peripheral suppliers and workstation manufacturers also stand to benefit from the market's growth. As the gap between personal computers and workstations steadily closes, more powerful chips are needed to accommodate the sometimes large amounts of memory required to run a piece of sophisticated text and graphics software.

Hardware — particularly peripherals such as monitors, scanners and laser printers — must adapt to the needs of the electronic publishing market. For example, Dataquest expects the scanner market for PC-based publishing systems to explode from 2,000 units sold in 1985 to 670,000 units in 1990. Workstation sales, meanwhile, are being driven by the dramatic increase in page composition software programs. More

The opportunities in electronic publishing are not limited to major systems vendors and software houses than 40 such programs were developed for the electronic publishing market in 1986.

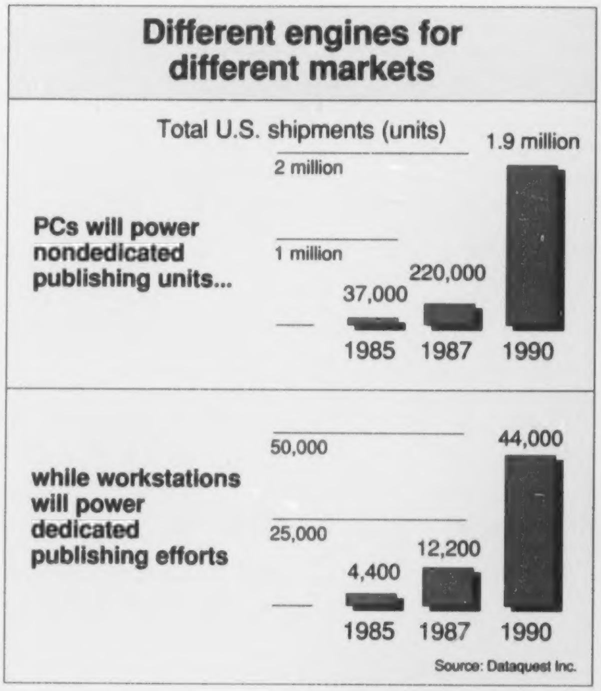
Interleaf Inc.'s success typifies the relationship between page-composition software and workstation sales. Founded in 1981, the company has consciously avoided building its own computers. "No thinking customer would want us for that purpose," Interleaf president David Boucher explains. His company, instead, has focused on developing software that runs on Apollo Computer Inc., Digital Equipment Corp. (DEC), IBM and Sun Microsystems Inc. workstations. Cambridge, Massachusetts-based Interleaf expects to hit $35 million in sales in its current fiscal year — double last year's performance. Among its biggest customers are Data General Corp. and Hewlett-Packard Co.

The electronic publishing market is growing so fast, in fact, that software producers are embracing nearly every marketing tactic available to leaf, besides maintaining its own direct salesforce, licenses its product to IBM and Kodak. Texet Corp. of Arlington, Mass., another leading producer, has similar deals with Compugraphic Corp. and Wang. Texet president Al Ireton says he needs both partners to counter the Interleaf/Kodak team. And Xyvision Inc. of Wakefield, Mass., yet another leader, has struck a similar deal with Allied-Signal, the big commercial publishing equipment vendor.

In spite of this excitement, the workstation companies are a little lukewarm on publishing. Sun Microsystems president Scott McNealy notes that the market generated 16% of his sales last year — for $34 million — but sees higher growth for his computers in the traditional workstation markets of electronic and mechanical design. Kodak and Compugraphic resell Sun hardware.

Apollo, better established in the design markets than publishing (4% of first-half sales for a $7 million total), is more eager to pursue the market. Clark Hills, senior marketing manager for publishing at Apollo, says a lack of system integration over the past two years "probably somewhat stifled the growth of the industry." Integration and the advent of color output devices will spur publishing sales, he believes.

Apollo resells low-end Interleaf software to spur its workstation sales. Interleaf, in turn, resells Apollo hardware for high-end applications. Apollo also has a program for "five-packs" of workstations, with buyers getting coupons that entitle them to discounts on software from Interleaf and Context Corp. as well as various laser printers and scanners.


Different engines for different markets

Source: Dataquest Inc.

Clark Hills, senior marketing manager for publishing at Apollo: System integration and the advent of color output devices will spur sales

Marketing strategies are crucial

Xerox thinks a lot of the publishing business. Software sales "could be much bigger than the numbers bantering around," says James Brown, marketing vice president for Xerox's Information Systems Division in El Segundo, Calif. He spearheads Xerox's two-pronged desktop publishing strategy — page makeup software for the IBM PC XT and its clones, licensed from Ventura Software Inc.; and homegrown software for Xerox's own 6085 workstation. Xerox decided to target what Brown estimates are the 2.5 million installed XTs rather than IBM PC AT or Apple Macintosh machines to avoid the herds of electronic publishing software houses developing products for the AT and Mac. (Xerox also has a commercial typesetting offering based on DEC minicomputers.)

Xerox is taking all possible marketing routes, including selling direct and through retailers as well as looking at value-added reseller (VAR) and OEM channels. Brown concedes that the different products and marketing techniques might make for some internal competition. "We want any and all," he says. "As long as the box says 'Xerox' on it, it's a major accomplishment."

Electronic publishing is getting crowded. "Like anything just really emerging, first there are lots of players and then there is a shakeout," Brown predicts. No need to ask which players will survive. "It will ring back to support and service and overall capability relating to the customer saying, 'Take care of me,'" he says.

Kodak couldn't agree more. Big customers, such as aerospace and heavy manufacturing companies, want to deal with a big vendor, asserts John Gell, product manager for Kodak's electronic publishing systems. Kodak also pursues a multitiered product marketing strategy, offering separate product lines for in-plant and commercial publishing applications. But it relies exclusively on direct sales. Kodak also has avoided developing or licensing a PC-based software publishing product because the company believes it would not sell at a high enough price to justify the expense of marketing it.

"Every single product [at Kodak] becomes a make-or-buy decision," Gell says when asked whether his company will continue to be an OEM customer of workstations and other electronic publishing peripherals. "If we could wave a magic wand, we'd like to manufacture all of it." To ensure that Kodak had adequate supplies of workstations on which to build its electronic publishing systems, the company initally took equity positions in both Interleaf and Sun. It subsequently sold its interest in Interleaf when that company emerged as a healthy competitor.

Workstations vs. PCs

Workstations face increasing competition from personal computers as the engine of choice for low- and medium-scale electronic publishing applications. CAP International, a Marshfield, Mass., market research firm that specializes in electronic publishing systems, estimates that three-quarters of all business users of PCs will use desktop publishing in some form.

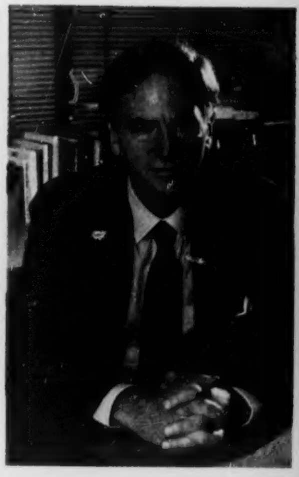
One personal computer that already has staked out firm ground in electronic publishing is Apple's Macintosh machine, whose Motorola Inc. 68000 architecture is particularly well suited to graphics applications. The Mac and Apple's LaserWriter printer family dominate the desktop publishing field. Dataquest estimates that Macintosh machines will outnumber all other types of PCs used for publishing by an 18-to-1 ratio by the end of the year. The market research firm does, however, foresee the ratio narrowing to nearly 5-to-1 by 1990.

The Mac's early lead over the IBM PC and PC-compatible computers will not be threatened for some time, insists John Scull, marketing manager for Apple's publishing products. "I'll get worried when the fundamental design architecture of the MS/DOS machine changes," he says, preferring to identify IBM PCs and PC-compatibles by their operating system than by brand name.

One element of Apple's electronic publishing strategy that could backfire is its refusal to sell publishing software or hardware other than its so-called core technologies of computers and laser printers. It leaves the opportunities to add optical memory, scanning, higher-end printers and typsetting equipment to Macintosh resellers. So far its much-publicized VAR encouragement program has produced few results.

Workstations face increasing competition from personal computers as the engine of choice for low- and medium-scale electronic publishing applications

IBM, on the other hand, seems eager to buy and market outside products in order to produce what the company's Quackenbush terms best-of-breed publishing systems.



APPLE's CEO Sculley: "We will not stand still as the MS/DOS world addresses graphics and ease-of-use issues"

Lianne Enkelis

Michael Solomon, vice president for sales and marketing for Aldus Corp., the Seattle company that makes the "Pagemaker" software that runs on the Mac, points out another potential Apple weakness. The Mac's closed environment "allows fewer third-party developments," Solomon says. That could cut Apple's dominance in the market. PCs, on the other hand, have an open environment.

Apple, however, may very well eliminate such criticism this year by introducing open-architecture workstations. "We will not stand still as the MS/DOS world addresses graphics and ease-of-use issues," vows John Sculley, chairman and chief executive of Apple.

Additional material for this article was contributed by associate editor David Card.

Investments in publishing systems spurred by savings

Electronics companies are buying electronic publishing equipment in the hope of saving money and reducing time to market

By Nancy McSharry

IBM last year spent more than $500 million on electronic publishing systems for its own use. The investment, although large in absolute terms, may well be *below* average — accounting for only 1% of the $50 billion giant's annual sales. Analysts and consultants who have watched electronic publishing evolve from a marketing concept to a full-blown capital equipment market now estimate that companies devote anywhere from 3% to 10% of their total revenue to publishing hardware, software and services.

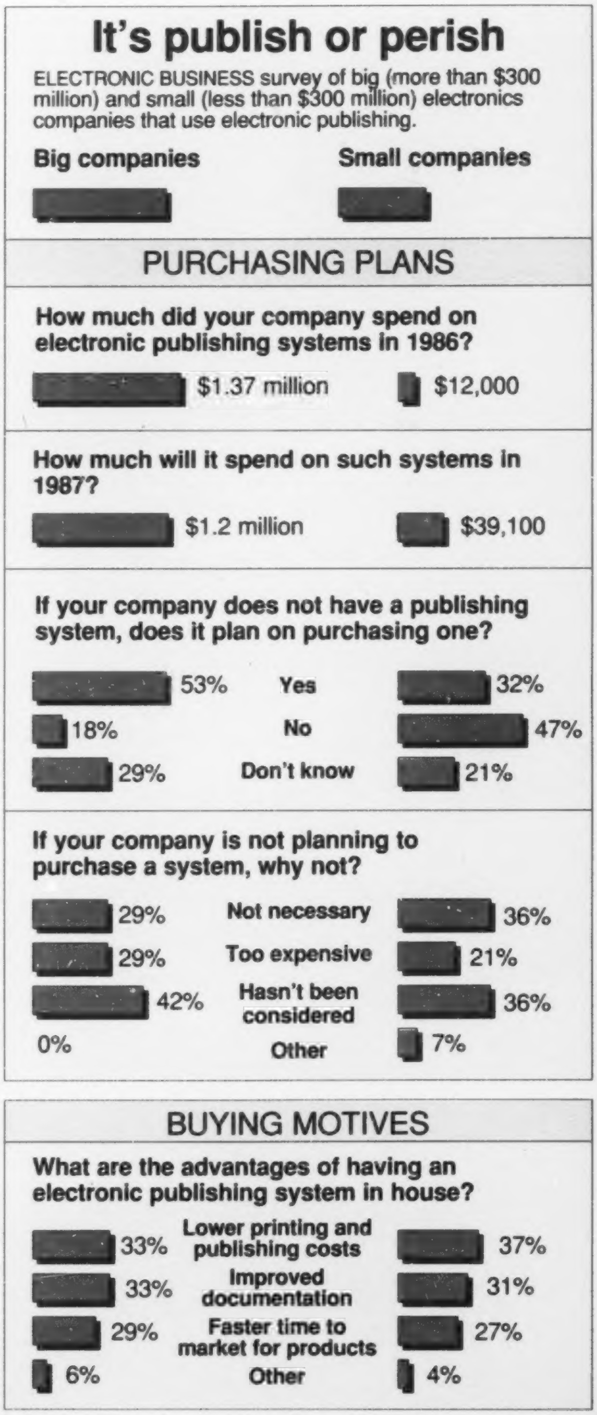
The market has no more devoted customers than systems makers, military contractors and their peripheral and component suppliers. All are investing enormous sums in workstations, laser printers, and the like, to take charge of meeting their own publishing requirements.

"Electronics companies with rapidly changing products and short times to market have people who are very sensitive to electronic publishing," says David Boucher, president of Interleaf Inc., one of the leading vendors of electronic publishing systems. "It may be 50% of the total electronic publishing market — at any rate, it's certainly a big chunk," he says, referring to the amount of electronic publishing systems purchased by electronics companies.

To assess how much electronics companies are investing in publishing systems and to determine how they are managing such investments, ELECTRONIC BUSINESS recently surveyed 1,000 operations and marketing managers at electronics companies. Five hundred of them were from the top 100 electronics companies, the smallest of which had $300 million in annual revenue. The other 500 were from companies with annual revenue less than $300 million. With a 10% response rate, the magazine has a 95% confidence level in its answers up to three percentage points.

Big vs. small companies

The major difference between the two classes of companies regarding electronic publishing is one of resources. Big companies have a lot more money to spend — and, no doubt, more incentive to do so — on publishing hardware and software. The average company in the top 100 last year spent nearly $1.4 million on electronic publishing systems. Its counterpart in the under $300 million category inves-



It's publish or perish

ELECTRONIC BUSINESS survey of big (more than $300 million) and small (less than $300 million) electronics companies that use electronic publishing.

PURCHASING PLANS

	Big companies	Small companies
How much did your company spend on electronic publishing systems in 1986?	$1.37 million	$12,000
How much will it spend on such systems in 1987?	$1.2 million	$39,100

If your company does not have a publishing system, does it plan on purchasing one?

Big companies		Small companies
53%	Yes	32%
18%	No	47%
29%	Don't know	21%

If your company is not planning to purchase a system, why not?

Big companies		Small companies
29%	Not necessary	36%
29%	Too expensive	21%
42%	Hasn't been considered	36%
0%	Other	7%

BUYING MOTIVES

What are the advantages of having an electronic publishing system in house?

Big companies		Small companies
33%	Lower printing and publishing costs	37%
33%	Improved documentation	31%
29%	Faster time to market for products	27%
6%	Other	4%

ed just $12,000. However, small companies plan to triple their publishing investments this year, while big companies may actually reduce their outlays somewhat.

Some other differences that emerge from the survey concern intent to purchase, hardware choices and vendor recognition. The majority of big companies currently without systems at least plan to buy them soon; only a third of small companies that now lack systems intend to purchase them. Big companies only exhibit a slight bias toward personal computer-based publishing systems, employing workstation-based and minicomputer-based systems nearly as much; nearly half of all small companies prefer personal computers (PCs), especially ones from Apple Computer Inc. Big companies are very much aware of the leading dedicated publishing system vendors — Interleaf, Texet Corp. and Xyvision Inc.; small companies barely know of them.

Shared objectives

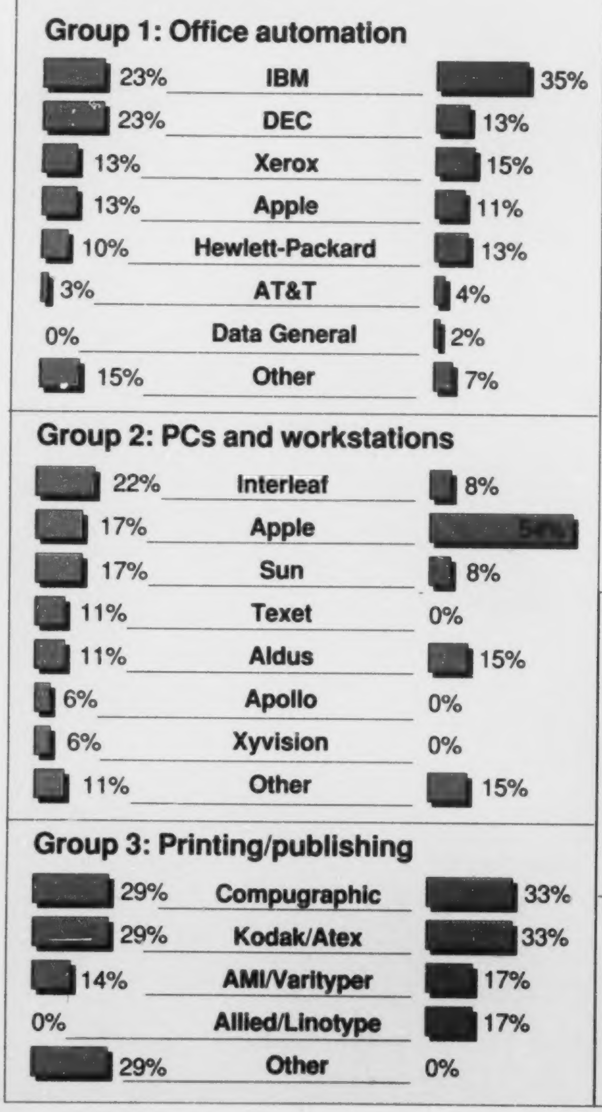
Lower printing and publishing costs are the chief objectives of both big and small companies in making an investment in electronic publishing systems. In big companies, however, improving documentation is just as big a motive. Reducing the time it takes to develop and bring a product to market is also a strong incentive for companies.

The president, chief executive or chief financial officer most often gives the final approval to buy an electronic publishing system, even though his influence is far greater in small companies. Fully 60% of the managers in small companies indicate that the president, chief executive or chief financial officer gives the big green light on systems purchases; 29% of their counterparts in big companies point to their top officers as having final approval. Interestingly, engineering vice presidents in big companies seem to have more purchasing power than their colleagues at small companies. Not so surprisingly, marketing executives exert an equal amount of influence at big and small companies.

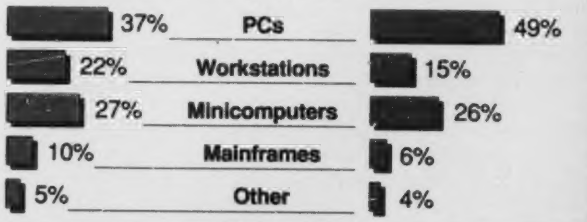
Continued

HARDWARE AND SUPPLIERS

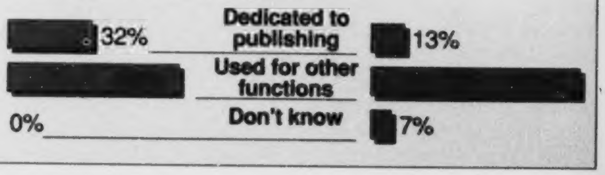
Who are your company's chief publishing system suppliers in each group?



What type of computer hardware drives your company's publishing system?



Are those hardware systems:

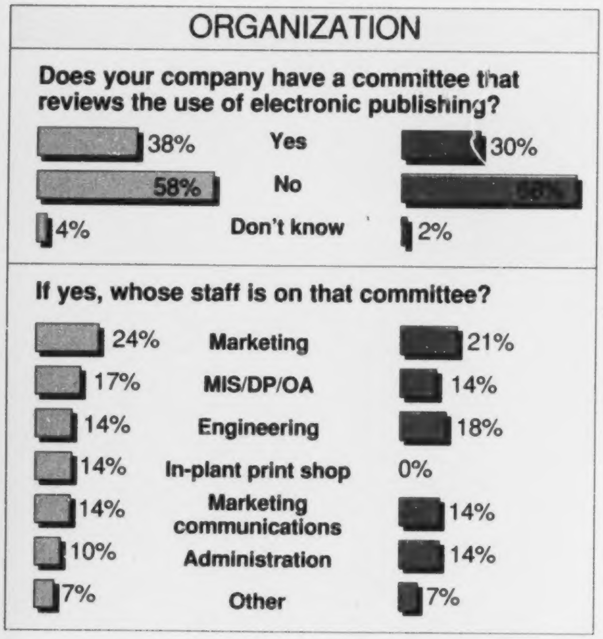


Organization and use

The engineering and marketing departments of big electronics companies clearly are the biggest buyers and users of publishing systems. Administrative offices, on the other hand, are where PC-driven laser printers are found in small companies. The management information system (MIS) departments in both big and small companies apparently have little use for publishing systems.

MIS professionals do seem to have some say in the selection of systems in companies where publishing committees exist. The number of committees, however, is staggeringly low in both the large and small companies. Only a third of the electronics companies surveyed by ELECTRONIC BUSINESS indicate they have committees charged with reviewing electronic publishing tools to be used by them. Where committees do exist, marketing personnel enjoy the strongest representation.

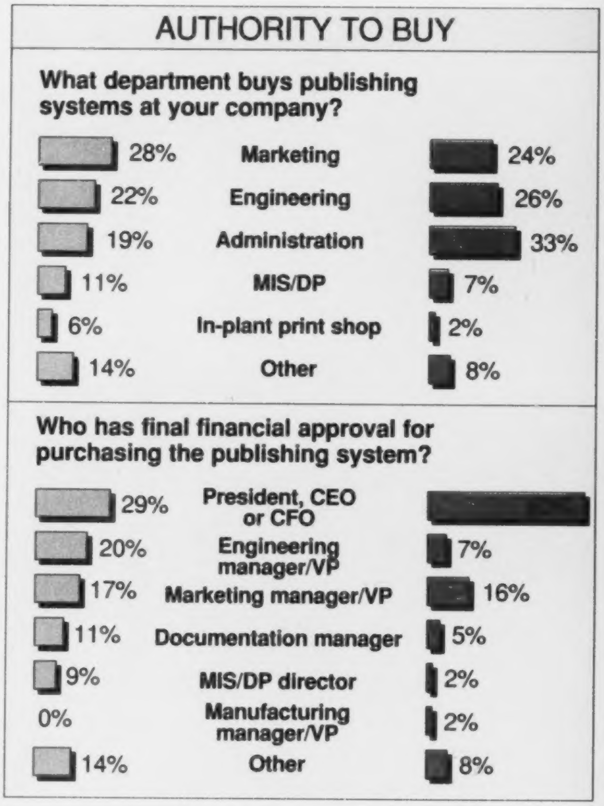
One explanation for the lack of separate publishing committees may be the fact that in a majority of cases publishing is just one of several applications of their computer hardware. Only a third of the publishing systems in big companies are strictly dedicated to the task; fewer than 15% of the systems are solely used for publishing in small companies. ☐


ORGANIZATION

Does your company have a committee that reviews the use of electronic publishing?

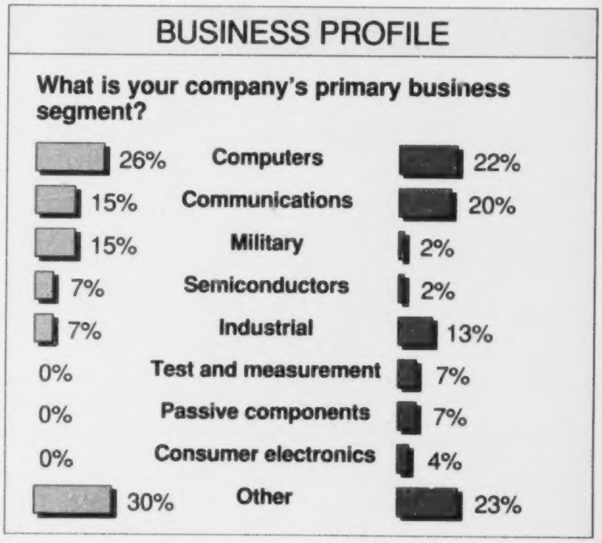
If yes, whose staff is on that committee?

The pages of this special Electronic Publishing section were produced on an Apple Macintosh Plus by assistant production editor Kathleen Hepburn, using Aldus Pagemaker software.


AUTHORITY TO BUY

What department buys publishing systems at your company?

Who has final financial approval for purchasing the publishing system?


BUSINESS PROFILE

What is your company's primary business segment?

Due to multiple responses, numbers may not total 100%.

COMMENT

Gallium arsenide: Management can no longer ignore it

The time has come for U.S. chip producers to decide what to do with this technology. Ignoring it will only compound the problems

The major U.S. merchant semiconductor producers have three choices in gallium arsenide (GaAs): ignore the opportunity created by the technology, react to it, or develop a capability in it. For better or worse most of them have adopted a modified "ignore" approach, watching and waiting to see whether anything happens in the market.

Such an approach could be dangerous. Those companies lingering along the GaAs sidelines may be on blind side of competitors, especially Japanese manufacturers and venture start-ups. They may be placing customers at a disadvantage. And they may be giving up on a potentially attractive, high-value market.

Tom Woodard
Director of the Electronics Practice
McKinsey & Company Inc.

**By Greg Summe
and Bob Neely**

The gallium-arsenide market can become quite attractive to U.S. electronics companies. It already has become extremely active. The number of merchant suppliers of GaAs components has tripled from 1983 to 1985. Industry and military research efforts behind GaAs are at an all-time high. IBM goes so far as to describe its GaAs research as "the largest alternative technology program at IBM." And the Pentagon has initiated a $135 million GaAs research program on the use of the compound to produce monolithic microwave integrated circuits (MMICs). (These chips achieve up to 100 gighertz frequency for ultrareliable radar in the advance tactical fighter program, airborne-shared aperture radar and the Stategic Defense Initiative.)

Nearly all semiconductor industry sources agree that GaAs shows technical promise: It enjoys better frequency capability, radiation resistance and optical characteristics than silicon. But, the industry acknowledges that GaAs devices are difficult and expensive to make. It involves purifying both gallium and arsenic and then combining the two elements in just the right way.

Greg Summe

Bob Neely

John Kilroy

But there is sharp discord over the timing and size of the potential opportunity in GaAs. Consequently, the level of commitment to GaAs varies widely among the U.S. and Japanese semiconductor producers, vertically integrated electronic equipment manufacturers and defense contractors. With a few exceptions, the U.S. semiconductor companies seem to be the least aggressive investors of these groups.

The bulk of GaAs investment being made today for the purpose of merchant sales seems to be made by Japanese IC makers (at least 12 with major programs and investments each exceeding $10 million per year) and U.S. start-ups (e.g., Gigabit Logic Inc., Gain Electronics Corp., Pacific Monlithics Inc. and Vitesse Electronics Corp.). Most traditional U.S. semiconductor producers have adopted a watch-and-wait investment approach. This may prove to be a sound strategy, but it is uncomfortably reminiscent of the transitions from vacuum tubes to transistors, transistors to ICs, and bipolar to metal-oxide semiconductors (MOS), where so many leaders in one old technology failed to embrace another new technology in time enough to maintain their positions of preeminence.

No one is predicting that GaAs will replace silicon as the dominant semiconductor type. But, it is likely to capture several high-value, performance-based segments of the semiconductor market (e.g., satellite and fiber-optic communication, ultra high-speed computers and battlefield applications). Consequently, it will be important for U.S. semiconductor producers to think clearly about their approach in determining their GaAs investments. This decision can, and should be, a systematic one, followed by substantial investment initiatives.

High price, but not for long

GaAs has far better performance characteristics than silicon due to its higher electron mobility, shorter minority carrier lifetime and direct-energy band gap structure. Such superiority currently comes at quite a price. A GaAs device frequently is orders of magnitude more expensive on a per-feature basis than a silicon-based integrated circuit with comparable functionality.

Despite the dramatic price difference, GaAs devices are being designed into a wide range of applications — principally in high-speed, high-radiation, or electro-optical environments such as direct broadcast satellite receivers, active filters for electronic warfare and fiber-optic repeaters. Those performance-based niches, of course, do not constitute a large market to date.

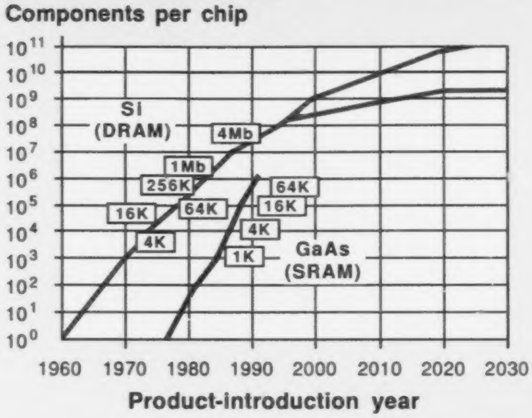
Most new technologies, however, start out that way — especially those that offer dramatic improvement in performance over their predecessors. As the cost of a new technology goes down, its appeal broadens beyond extreme performance niches. The lower cost per function permits a greater functionality at an equivalent price or the same functionality at a lower price.

For example, the transition from bipolar to MOS for most digital applications was accelerated dramatically with the introduction by Intel Corp. of the 1K dynamic random access memory (DRAM). Customers that adopted Intel's technology early (e.g., Digital Equipment Corp. and Hewlett-Packard Co.) were able to make more rapid systems advances. Even though GaAs will never replace silicon in low-cost applications, its performance advantages cannot be ignored. And on an absolute basis, it will increasingly take market share from silicon.

The most exciting markets for GaAs are ones that it will create or expand. As a result of replacing silicon in high-performance applications and expanding the market through enabling new applications, GaAs may turn out to have a much larger share of the overall electronic market than a conventional analysis would predict.

Every top semiconductor producer, therefore, should be asking itself when and how much — *not if* — it should be investing in a strong capability in GaAs. Such a producer can then lay out a capital and manpower investment plan for developing the capability. This is an important decision since even today it would probably require on the order of $50 million. To catch up in a more mature future market, the requirement could be multiples of that figure.

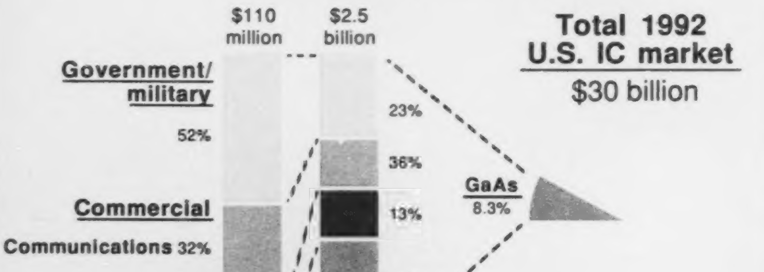
Projected progress of silicon and GaAs integrated circuits



Source: Stanford Integrated Systems Center, Gigabit Logic Inc., McKinsey & Co.

U.S. GaAs market potential

Percentage of total IC market*



*Estimates

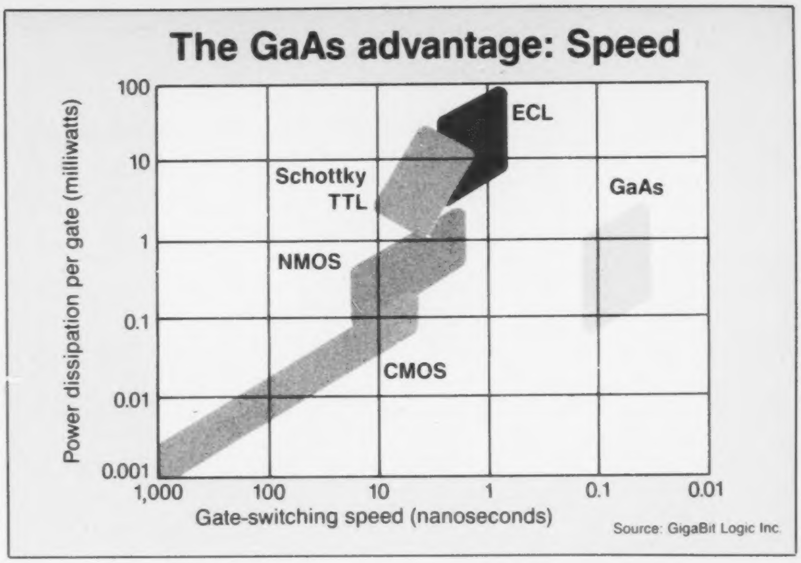
Sources: Gnostic Concepts, Integrated Circuit Engineering, McKinsey Analysis

To develop a coherent strategy for participating in GaAs, a company must start with a clear picture of the performance potential of the technology and its potential impact on the company's existing markets.

Performance potential should be determined by looking at the rate of technical progress and the ultimate potential performance limit of the technology. A useful tool for assessing such potential is the "S curve," which expresses performance versus the cumulative investment required to achieve that performance for a given technology. Typically, replacement technologies start out substantially further behind in performance and achieve clear superiority about the time the leaders in the old technology wake up too late to switch curves. Even though GaAs is clearly behind silicon in cost/complexity of design and application, today, it has higher performance potential due to its higher electron mobility.

The impact of GaAs on the company's markets will be determined by both performance and cost. The value of performance is specific to each application. For example, it is high for speed-limited computer applications and low for applications where speed is not limited. Such value is measured by determining the cost of replacing older technologies.

The value of performance is relatively static and changes slowly. The cost side of the equation, however, is very dynamic and the eventual limit much harder to assess, therefore, the cost is much harder to predict. Two common analytical traps in comparing costs are: failing to consider explicitly total system lifetime costs (including service, supplies, downtime)



The GaAs advantage: Speed

Source: GigaBit Logic Inc.

and underestimating the cost decline of new technologies. To estimate cost declines it is frequently necessary to go well beyond conventional analytical techniques, especially in cases like GaAs where there are significant performance differences from the existing technology.

One useful approach is to estimate how the total system cost could evolve for functionally equivalent products. After establishing a baseline, the value of additional functionality for a specific application can be contrasted to the base cost differences. This, in turn, can help estimate the approximate time that the new technology will become cost-competitive in applications where functionality has increased.

For example, the performance and price of a 1K GaAs static random-access memory (SRAM) far exceeds its silicon counterpart. However, if the GaAs part were designed as a functional equivalent of the silicon device, the looser design rules would result in higher yields and cost would be much more competitive — perhaps falling within 50% of the silicon part. Even though GaAs and silicon are not equal as functional equivalents, such analysis helps illuminate how large the intrinsic cost differences are, and how they might change.

In some applications, the cost of achieving a solution in silicon may be prohibitive even now. Supercomputers are one such application. To build the next generation of such machines, optional computing techniques and architecture are being considered in addition to dramatically faster semiconductors. Computer manufacturers with active GaAs programs such as Fujitsu Ltd. and IBM have far greater design flexibility in the menu of architecture and component choices than those without access to blindingly quick devices.

Executing on a strategy

Once a company has a clear view of what GaAs's impact may be on its markets, the next steps are to decide what level of participation is appropriate and to organize such participation. To decide whether to adopt a reactive strategy or pursue aggressive development, the company should actively consider its product lines and market positioning.

If, for example, the company's chief product lines are low- and medium-speed complementary metal oxide semiconductors (CMOS) or if its customers are likely to continue to have lower speed applications, then a watch-and-wait strategy may be correct.

On the other hand, if the company depends strongly on high-speed bipolar products, GaAs poses a much more significant near-term threat to it than to companies dependent on MOS products. The bipolar-based company therefore should be a more aggressive developer of GaAs, attacking its own products — even at the expense of of short-term profits, if necessary. Choosing any other course is likely to result in loss of market position, since bipolar devices are the most vulnerable given their relative position on absolute performance.

If any of the major U.S. semiconductor producers is planning on increasing its participation in GaAs and protecting high-performance product areas from Japanese or start-up attack, the time is drawing near to initiate its GaAs investments. At least 12 Japanese semiconductor manufacturers, including Fujitsu, Hitachi Ltd. and NEC Corp., are aggressively trying to develop GaAs. Japanese suppliers already dominate worldwide production of GaAs wafers. Less well-funded U.S. start-ups (e.g., Gigabit Logic, Gain Electronics) are also aggressively attacking the market, even though they have not achieved the success of some better-funded domestic efforts such as Ford Microelectronics $30 million GaAs program.

The investment and organizational implications are quite different for the aggressive development approach. In a watch-and-wait mode, a company can allow existing development groups for silicon to oversee its GaAs effort and monitor industry progress, but not without some risk of neglect or over-pessimistic evaluation. To pursue an aggressive GaAs development strategy, it is important that the effort be split off from the company's mainstream silicon organization. Moreover, adequate funding will be necessary but hard to receive in most capital spending environments where silicon benefits are far more tangible and easily identified.

It takes courage as much as financial analysis to move a specific organization into a new technology. Intel, for example, showed boldness in 1983 when management mandated that it shift from n-channel MOS technology to CMOS technology. If bold moves are not taken, there is a much higher likelihood that the development will be a lot more restrained because members of the organization either resist change (it threatens their skill base) or are just not comfortable working the new technology.

Decide today, not tomorrow

The electronics industry has seen tremendous change in the last three decades. At one time it was forecast that the total market for computers could never exceed 25 mainframes. Including personal computers, the current population of computers is 15 to 20 million units worldwide.

The computer explosion vividly demonstrates the fact that potential applications for a new technology are often far larger than initially expected. GaAs promises to be one of those technologies. U.S. semiconductor producers had better decide today whether, when, and how much to participate in this potentially very attractive market.

Summe is an associate in the Hong Kong office of McKinsey & Company. Neely is a partner in the management consulting firm's Los Angeles office.

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A CAHNERS PUBLICATION

MARCH 1, 1987

Electronic Business

Japanese computer makers gamble on Unix software

Tax reform's impact on the U.S. electronics industry

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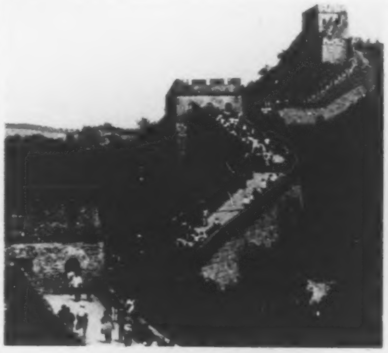

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Development of telecommunications is receiving top priority in China's current five-year plan.

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Cover illustration/Bill Cooke

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U.S. semiconductor market sees hope for this year

Niche companies are star performers. New microprocessors and tight inventories may win in 1987

It was nice that 1986 ended with a bang for the U.S. semiconductor market. The Semiconductor Industry Association's (SIA) book-to-bill ratio, the market's most watched (although sometimes misinterpreted) indicator, had slowly inched its way up toward unity in the first part of the quarter and then shot up to 1.08 in December, amid an encouraging environment of growing orders and shipments. SIA's statistics show that the quarter's revenue, up 17% for all semis (18% for integrated circuits) over a year ago, managed to push 1986's growth over 5%. Market research firm Integrated Circuit Engineering Corp., which claims to have correctly forecast a year ago the performance of the U.S. market for 1986, does not expect any better news for 1987 because it predicts that the production of electronic systems in the United States, the markets that use semiconductors, will grow only by 3%, about the same as last year.

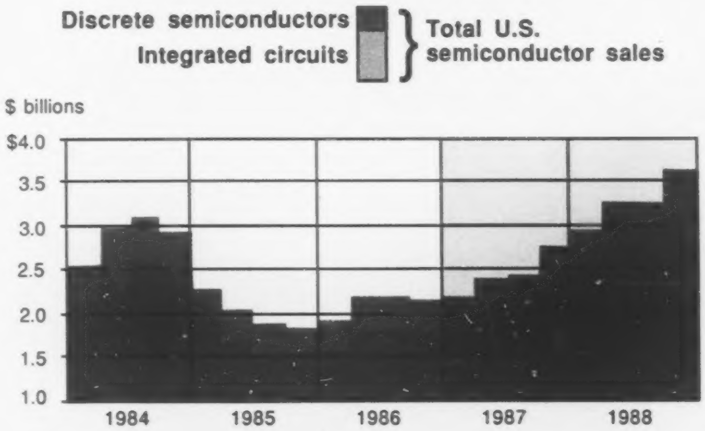
The SIA's figures report on the market, however, not on those which supplied the chips and partook of the gain. But it is likely that local chip makers this year may recover some share of their turf.

The picture has been much better for chip makers that concentrate on market niches. Silicon Systems Inc., a chip maker 30 times smaller than Intel, which concentrates on ICs for the booming Winchester disk market, increased sales by 54%. Integrated Device Technology, a complementary metal-oxide semiconductor (CMOS) random-access memory (RAM) specialist that is 20 time smaller than Intel, increased its fourth quarter sales by 30%, about the rate that Intel used to grow when it was the size of IDT. And VLSI Technology, one of the pioneers of application specific ICs (ASICs) and computer-aided engineering (CAE) software, one-tenth the size of Intel, grew by 42% with respect to 1985.

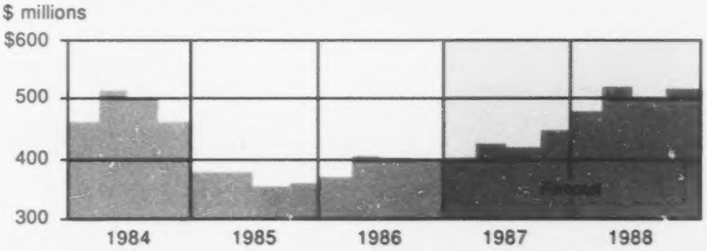
Hopes for the larger chip makers could be dimmed if the current spurt is due to customers rebuilding inventories rather than increasing real demand. But customers are managing inventories better today than at any time in the past. Jerry R. Junkins, president and chief executive of Texas Instruments Inc., whose sales of ICs are almost double Intel's, makes a convincing argument for lean inventories. At a presentation last quarter before the New York Society of Securities Analysts, Junkins said that a TI survey revealed that U.S. electronic equipment manufacturers had "lowered their desired inventory-to-sales ratios [since 1982] from 11 to six weeks," almost one-half. TI has developed ship-to-stock and just-in-time programs with "55 leading electronic equipment companies" up from only seven in 1984. This reduction in the inventory required to maintain production is tantamount to a gap of five weeks in orders. Although there may be still more economies left to implement in semiconductor inventories, it is very likely that, in 1987, equipment manufacturers' purchases of semiconductors may grow at the same rate as their production of equipment.

ALBERTO SOCOLOVSKY

U.S. semiconductor sales



U.S. distributors' shipments of semiconductors



Historical data: Semiconductor Industry Association
Forecast: Cahners Economics

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, showed a mild decline in the second quarter, followed by a slight recovery in the third quarter. For 1986, production is expected to be up a scant 0.9% from the previous year. This year, steady improvements are forecast throughout the year pushing production up 3.9%.

The Cahners Early Warning Indicator (CEWI) is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index. It forecasts probable business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 103.9 level forecasts using the CEWI for the end of this year indicates that the average for all of 1987 should be 3.9% above 1986.

Readers can obtain a brochure explaining the CEWI method from Cheryl Patstone, economist, Cahners Economics Department, 3021 Tisch Way, Suite 100, San Jose, Calif. 95128.

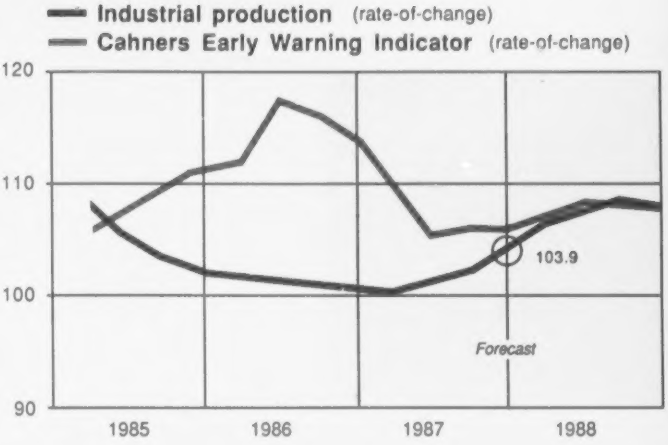
Defense and space equipment

Growth in the defense industries continues to be restrained by the cutbacks in government funding that were made in fiscal years 1986 and 1987. Those back-to-back budget cuts of 4.2% and 2.5% (after adjustment for inflation) forced the Pentagon to stretch out many procurement programs and caused growth in equipment production to slow from nearly 10% (on a year-to-year basis) in late 1985 to just 5% by mid-1986. The growth rate stabilized at 4% to 5% in the third quarter and is expected to remain near that level into early 1987. But President Reagan's recent request for a modest 3% real increase in the fiscal year 1988 defense budget suggests that market growth will dip lower in the late 1980s. Production, which grew 1.5% between last year's second and third quarters, should post an overall increase of 5.5% for 1986.

Aircraft and parts

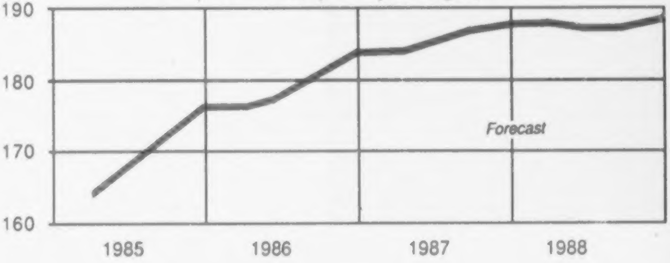
Total production of commercial and military aircraft increased 2.5% in last year's third quarter (outpacing a year ago by an 11% margin). A tapering off in defense procurement is expected to pull the growth rate below 2% in the fourth quarter, but manufacturers will still see a real gain of 12.3% for 1986 as a whole, the industry's best performance in seven years. A recent upsurge in demand for commercial equipment will give manufacturers a near-term boost, softening the negative effects of a leveling off in the larger defense sector. Production should increase 5.5% in real terms in 1987.

Economic indicators



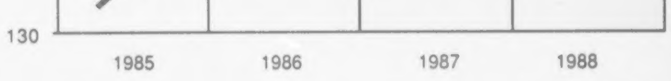
Industrial production: Defense and space equipment

(1977 = 100, quarterly averages)



Industrial production: Aircraft and parts

(1977 = 100, quarterly averages)



Historical data: Federal Reserve Board
Forecast: Cahners Economics

Unix: Japan jumps into the U.S. computer marketplace

From workstations, to chips, to the Sigma project, it looks like Japan is betting more and more on Unix

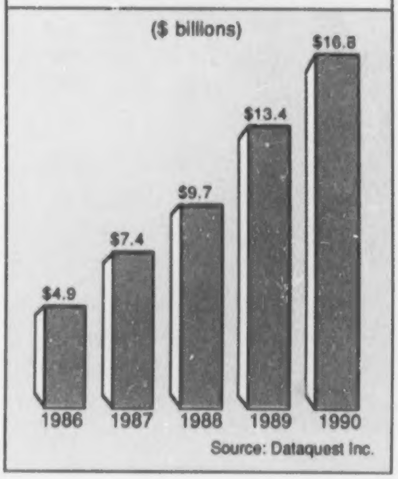
As director of international marketing for the Computer Systems Division of Gould Inc., Luis Zuniga has been trying to increase Gould's presence in Japan. In searching for a Japanese business partner to help smooth the way, Zuniga has made an interesting discovery. Japanese companies are most anxious to avail themselves of Gould's Unix expertise. "Unix gives them an excellent avenue to catch up," explains Zuniga. "They have an extremely high interest in Unix."

Evidence of that interest is beginning to surface everywhere. Licensing of the Unix source code in Japan has been growing at an annual rate approaching 60%. Japanese firms have been locking up such Unix powerhouses as AT&T, Motorola Inc. and Sun Microsystems Inc. in partnerships that give them access to Unix technology and product. NEC Corp., Hitachi Ltd., Mitsubishi Corp. and Sony Corp. are already marketing Unix-based workstations in Japan. And NEC has now begun selling its own EWS-E engineering workstation, along with a line of 32-bit Unix-based minicomputers, in the United States as well. Fujitsu Ltd. and Hitachi, meanwhile, are collaborating on development of a 32-bit microprocessor that will support Unix (along with the nascent real-time operating system, TRON). And most important of all, the strategic and secretive Sigma project — backed by Japan's powerful Ministry of International Trade and Industry (MITI) and intended to give Japan Unix software leadership — is making quiet progress.

For NEC, Unix is a "primary strategic action item," according to Frank Girard, vice president of systems marketing for NEC Information Systems in Boxborough, Mass. "The momentum of Unix in the U.S. marketplace is pretty clear," observes John Reimer, manager of advanced products for Fujitsu Microelectronics in Santa Clara, Calif. "To not address that momentum, I think, would be asking for trouble."

Actually, there's more than market momentum attracting the Japanese to Unix. Lacking a substantial installed base tied to their own proprietary operating systems and historically unproductive in developing applications for other systems environments, software standardization has long been Japan's chief hope for penetrating world computer markets. Operating systems that have already emerged as standards are supported by well-stocked applications libraries and offer large potential hardware markets. Such are ideal conditions in which the Japanese can best exploit their vertical integration and manufacturing capabilities to concentrate on the production of low-cost hardware.

Worldwide sales of Unix-based computer systems



Source: Dataquest Inc.

This, to date, has been their strategy in mainframes (with the exception of NEC) and personal computers (PCs). In each case, Japanese firms have sought to piggyback IBM software standards. But those strategies may no longer be viable. In mainframes, the 1982 FBI sting operation that allegedly caught Japanese executives offering to illegally obtain IBM's proprietary MVS/XA software code led to U.S. court-approved settlements and notoriety that cost Hitachi and Mitsubishi Corp. dearly. IBM has more recently turned the heat up on Fujitsu as it more aggressively protects its strategic systems software. As a result, many in Japan now feel the IBM-compatible strategy is doomed. Meanwhile, in personal computers, the Japanese find themselves squeezed between innovative American and lower cost Asian compatible makers and have managed only minimal U.S. market penetration.

Market momentum

Enter Unix, an emerging nonproprietary standard whose licensing has been encouraged by its developer (AT&T). Unix, additionally, seems tailor-made for the Japanese. As perhaps the most "portable" of all operating systems, Unix can be run on an unusually broad range of processors. Unix code is currently executed on microcomputers, Cray Research Inc. supercomputers and just about everything in between. With the worldwide market for Unix-based computer systems expected to reach $16.8 billion by 1990 (according to Dataquest Inc.), it is impossible to imagine a more ideal opportunity for Japan's nonpareil high-volume hardware manufacturers.

"Unix represents an opportunity to have portability between a complete family of products, ranging from personal computers, desktop workstations and advanced workstations up to multiuser departmental and applications processors and going all the way up to mainframes," explains NEC's Girard. Asked if such PC to mainframe Unix capability was in NEC's future, Girard responded: "Yes."

NEC and other Japanese firms are

Jean-Francois Allaux

focusing first on the engineering workstation market where Unix has proved especially strong. Strong enough, for example, to propel Sun Microsystems, a 1982 start-up, to sales of roughly $200 million in just the last two quarters (July-December, 1986). Sun has excelled in building hardware platforms and communications optimized for the Berkeley 4.2 version of Unix. Now Sun executives recognize that they are a primary target to strategists in Tokyo.

"The Japanese are definitely going to be a factor in the workstation market in Japan and here," says Joseph Roebuck, Sun's vice president of sales. "Workstations are a top priority for the Japanese as a country, as a government. All the leading computer companies in Japan are working with MITI to address the market." Roebuck concludes: "We've got to be prepared to compete with them both in Japan and in the U.S." Charlie Perrell, director of intercontinental sales and support for Sun, also expects a flurry of activity from the Japanese centered on Unix systems. "We believe that will be the operating system they concentrate on. There is no other choice. It is here. It is today."

But the Japanese, who have a knack for such things, are preparing for tomorrow too. And that's why they're investing an estimated $120 million in the Sigma project. "Sigma, as far as I am concerned, is the most significant thing going on in the world, as far as Unix," contends Larry Crume, president of AT&T's Tokyo-based Unix Pacific subsidiary. Crume should know. He led the AT&T team that developed Unix System V. Now he heads up AT&T's Unix development and licensing activities in the Far East and is one of the few Americans involved in the Sigma effort. Indeed, it is AT&T's cooperation with the Japanese on the Sigma Project [ELECTRONIC BUSINESS, Feb. 1, 1986 p62] that lends so much promise to their thrust in Unix.

The ostensible goal of Sigma is the

improvement of software development productivity through the creation of a standard Unix software development engine that would eventually network all of Japan's software engineers. But Crume believes that the creation of a software development workstation may eventually prove to be one of the lesser accomplishments of the project.

Crume is convinced that Sigma is going to give the Japanese a leg up in Unix markets. "I think they'll lead the world in Unix applications software. What they're going to build is solution systems. They're going to build solution systems for consumers," says Crume. He cites banking and point-of-sale systems as two areas where Sigma software solutions could emerge.

What has impressed Crume most is the way Sigma's 40 Japanese software engineers (contributed by their employers to the project) are able to draw on the technical expertise of the entire Japanese nation. Each operating group in the project interacts with a committee that includes technical experts from both industry and academia. As a result of such broad input, the project draws on the resources of all Japan and addresses issues that might otherwise be overlooked.

At one recent committee meeting, for example, the issue of common logical forms for floppy disks used by Unix workstations from different vendors was unexpectedly raised. Common logical forms would allow disks to be freely interchanged between different hardware systems. "While that's not necessarily a part of the Sigma software productivity project, it's the kind of thing that starts to get into the project as they get everything aligned," reports Crume. "The point is that sort of thing comes in even though it's not the major thing."

Because Sigma is structured to absorb contributions from Japan's broader technical community, Crume believes its accomplishments will transcend its stated goals. The software development engine itself has been specified and its capabilities (which include a 32-bit processor, a cathode ray tube with at least 1,000 by 1,000 pixel resolution, at least four megabytes of main memory and the ability to execute one million or more instructions per second) are certainly not exceptional. But that standardized engine is just the start, according to Crume. It will be the template for other workstations designed for a variety of applications. "That Sigma workstation will be moved by peripherals and software" into other vertical applications, Crume predicts. Once the Japanese have standardized the base hardware, they can develop the software and specialized peripherals, such as keyboards, displays, mass storage and others, tailored to specific vertical markets.

The Japanese are likely to benefit from the synergy that develops between their Unix hardware and software. "The most successful software is that software developed using the system it's going to run on," explains Crume. Hence, the software development engine, modified for specialized applications, becomes the platform of choice for the applications software it was used to develop. Sigma, therefore, becomes the cornerstone of Japan's software and hardware ambitions in Unix.

Just as the Sigma project draws on the entire technical expertise of the nation, it educates the nation in the systems and standards it produces. "I think that the Japanese are pretty shrewd business people in the sense that they build the infrastructure in their own companies in using things. Then they build the infrastructure in their own country by making the product attractive in their own country. Then, it's an easier move outside to other countries," says Crume. By concentrating first on solving an internal problem — inferior software development capabilities — and by involving the entire country in the effort and in the solution, the Japanese develop a capability that eventually can be exported.

Larry Michels, president of the Santa Cruz Operation, a company that sells Xenix systems software (a derivative of Unix), along with Unix applications packages, describes the Sigma Project as "scary." "When the Japanese band together, I just sort of look at it and shudder." The cooperation of Japanese industry leaders, along with the allocation of so much capital to what is essentially a long-term project, give the Japanese powerful advantages over U.S. firms with myopic earning horizons.

Michels sees the Sigma project as a concerted effort by the Japanese to play catch-up in the computer industry. "The fact is the Japanese have not succeeded in any real measure in computers in this country . . . I see the Sigma project as a step of banding Japanese industry together for a longer term solution to try and be more effective in competing in the U.S. market."

Some Sigma doubts

Although there appears to be consensus strategy behind Sigma in Japan, it is worth noting that the project has harbored internal debate, has left some difficult questions unresolved and is in some ways controversial.

Unix, to begin with, is more like two standards than one standard. Scientific and technical users generally demand the higher performance Berkeley version, while System V is more often the choice in commercial environments. The Japanese spent a lot of time trying to establish exactly which version they would specify for the Sigma workstation. Although Sigma did finally settle on System V, the long delay apparently did not please some of Japan's Unix hopefuls. Toshiba Corp. entered into partnership to resell the hardware of Berkeley apostle Sun. And Sony Corp. developed its own low-end engineering workstation around Berkeley 4.2. Crume says that Sigma will add some commands from the more speedy 4.2 in moving toward a harmonized Unix that should parallel the Berkeley-System V convergence being engineered by AT&T and Sun.

As yet unresolved is the question of whether the Japanese will push Unix in their business systems. The question is a tough one. On the one hand, Unix has never had the commercial penetration that it achieved in the engineering and scientific markets. This would seem to argue against a commitment to commercial Unix. On the other hand, it is in part the dearth of applications software that has held back commercial Unix. As such, the major opportunity for Sigma may actually lie in churning out commercial Unix applications. Crume suggests the Japanese will go this way; producing total software solution systems for retail, banking and other industries. But Michels of Santa Cruz Operation believes that the Japanese see Unix as a development environment and as a standard for technical users but do not really see Unix as a business software environment. Sigma, he argues, could divert some of its programmers into applications development for PC-DOS and other established commercial operating systems.

In spite of all its potential, the thrust toward Unix is not viewed with universal equanimity within Japan. It is now accepted that the strategy of piggybacking IBM's software standards, though moderately successful in mainframes, has become increasingly risky as IBM more aggressively protects its systems software. Why then, should Japan tie its fortunes to yet another U.S. giant? In committing to Unix, the argument goes, Japan is putting itself at the mercy of AT&T, which is still the most powerful force in Unix development and to whom the Japanese must pay licensing and royalty fees. True, AT&T, which is an investor and participant in Sigma, has been cooperative in ways IBM has never been. But, the Unix skeptics say, Unix still leaves Japanese industry dependent on a foreign firm.

For this reason, the Japanese have made some steps toward developing their own proprietary systems software: TRON. There is no question that the Japanese would like to see this new operating system, already being touted as the technology for the 1990s by its developer, Tokyo University professor Ken Sakamura [ELECTRONIC BUSINESS, Nov. 15, 1986 p82], take root. TRON, which is designed to better harness the speed of 32-bit and the next generation 64-bit microprocessors, is an ambitious undertaking.

But successful new software environments are few, far between and awfully slow to develop. At best, if it is a spectacular success, TRON will become an alternative software environment of some consequence in the next decade. After all, it has taken Unix, for all its unique advantages, more than 15 years to approach the status of standard.

A familiar drama

Meanwhile, a disturbingly familiar drama is being enacted. "Strategic alliances" are now being touted as the new master keys to Japan's Magic Kingdom. With the Japanese dangling the ever-tantalizing, mirage-like promise of sales in Japan as incentive, American firms are unburdening themselves of their own Unix secrets. Gould's Zuniga, along with other American executives, accepts that his company must share technology to win access to Japanese markets. It may well be that the cooperation of AT&T with Sigma, as well as the technology exchanges between Motorola Inc. and Toshiba, and the remarketing arrangements between Sun and Toshiba will benefit all parties. It is already clear that these arrangements serve the long-term strategic interests of the Japanese and, at a minimum, the shorter term interests of their American partners. History, however, suggests that Unix technology will be transferred far more swiftly and surely than the Japanese market is unlocked.

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MANAGEMENT

The widening trade gap in Korean electronics

South Korea is currently running a $7 billion trade surplus with the U.S., some of it in Japanese components

By Andrew Tank

South Korea's booming electronics industry is worrying U.S. trade officials.

"It's a huge gaping back door," says one senior U.S. diplomat in Seoul, referring to the high proportion of Japanese-made parts in Korean exports to the United States. This counteracts the impact of devaluing the U.S. dollar against the yen since the Korean currency has been devalued almost as much. The result is that U.S. economists predict Korea will earn a $7 billion trade surplus with the United States this year, but incur a $6 billion deficit with Japan — with many of the U.S. dollars indirectly being recycled to Japan.

Korean goverment officials exhort companies to do something about this — buy more from America, sell more to Europe, develop indigenous technology — but meanwhile the fortuitous turn of events is consolidating South Korea as an even stronger electronics producer.

When all the figures are in, it is expected that Korea's electronics production will have topped $10 billion last year, compared with $7.2 billion in 1985, according to the Electronics Industries Association of Korea (EIAK). Exports in 1986 were expected to have been up at least 50% to $6.5 billion, with about two-thirds of them destined for North America.

The detailed trade statistics for the first nine months of 1986 show that substantial gains have been made across the board compared with the same period last year: video tape recorders up 189% to $361 million, personal computers up 88% to $477 million, semiconductors up 39% to $1,015 million. Overall, exports of consumer products and components each accounted for around 42% of the total, while industrial electronics represented just 16%.

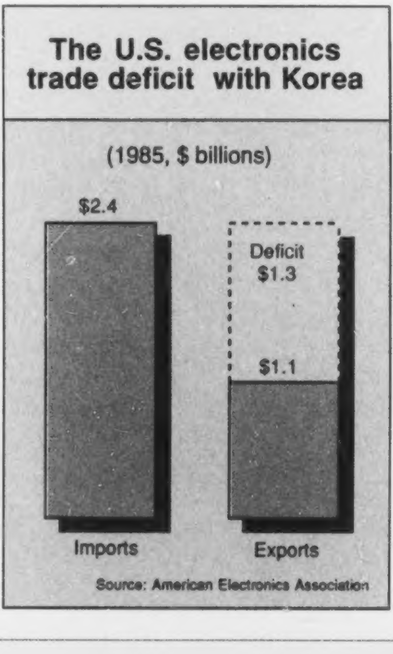
The snag is that all this trade is very lopsided. Japan accounts for about 50% of imports but buys just 10% of exports. The U.S. buys over 60% of exports but sells just 35% of imports.

A protected market

Says the executive vice president of the American Chamber of Commerce in Korea, General Frederick C. Krause: "The fundamental problem is that this market is only very selectively open to the inflow of U.S. goods and services. It's a very protected market."

In the 1960s, the Japanese took the leading position as supplier of technology and parts from the United States. This was due to geographical proximity, a shared language with many elder business executives and through offering more competitive deals.

However, the Koreans are not entirely happy with the way this has turned out. Says the manager of the international department at the EIAK, Yorm Kim: "Our industry is not satisfied with the technology that Japanese companies have transferred. The core technology was not given to us. Especially in the high technology we don't believe they will transfer enough technology."


The U.S. electronics trade deficit with Korea

Source: American Electronics Association

Adds Marvin J. Winship, director of the International Executive Service Corps in Korea and a long-time resident: "Their relationship with Japan is a love-hate relationship. Other things being equal they would generally prefer an American joint venture to a Japanese one."

The difference between the American and Japanese approach is summed up by K. Mook Choi, general manager at Goldstar Semiconductor: "U.S. companies are likely to analyze the good effects and if they see profits they will transfer the technology. The Japanese are worried about the so-called boomerang effect [Korean exports competing with Japanese ones] so even if they see a profit they will be more reluctant to transfer technology."

There have been recent reports that Japanese firms have been reluctant to supply sufficient quantities of key components — such as head drums for video cassette recorders, thermal printer heads for facsimile machines, microwave oven doors and integrated circuits — to maintain greatly increased flows of Korean exports to the United States. This may be due to mundane supply problems rather than perfidious scheming, but it is clear that at present the whole Korean success story is dangerously dependent on Japan.

This dependency is highlighted by a recent survey done by Samsung Electronics on the proportion of imported parts as a percentage of the total value of the product: printers, 65%; personal computers, 60%; cathode ray tube ter-

The leading South Korean electronics firms in the first half of 1986

Corporation	Sales[1] ($ millions)	% change[2]	Profit[3] ($ millions)	% change[2]	Debt to equity ratio	Assets[4] ($ millions)
Samsung Electronics	$1,256	+23.1%	$23.7	+26.2%	6.60	$2,346
Goldstar Co.	890	+7.1%	9.3	+104%	4.97	1,137
Daewoo Electronics	285	+49.9%	3.8	+194.6%	9.70	750
Goldstar Cable	215	+26.0%	4.1	N/A	4.38	344
Samsung Semiconductor	173	+30.6%	6.6	+22.3%	7.37	853
Taihan Electric Wire	142	+27.3%	3.4	+26.2%	2.44	298
Samsung Electronic Devices	124	+17.6%	3.2	-23.0%	2.71	203
Hyundai Electronics*	110	+120.0%	N/A	N/A	N/A	N/A
Goldstar Semiconductor*	100	+25.0%	N/A	N/A	N/A	N/A
Samsung Electronic Parts	89	+61.3%	3.5	+30.0%	2.43	152
Anam Industrial	83	+47.6%	0.7	N/A	3.33	178
Goldstar Telecom	73	+20.7%	2.0	+163.6%	1.21	125
Oriental Precision	49	+65.6%	0.4	+183.3%	3.37	118
Goldstar Electric	47	+27.6%	-7.4	N/A	10.74	143
Goldstar Instrument and Electric	46	+14.3%	1.3	+33.3%	4.76	106
Dongwon Electronics	32	+20.7%	0.4	-53.0%	3.06	42
Shinyeong Electric	30	+13.6%	-3.4	N/A	4.45	88
Maxon Electronics	28	+61.0%	0.8	+100%	1.70	35

[1] Sales for the first half of 1986
[2] Percentage change compared with the first half of 1985
[3] Net income after tax for the first half of 1986
[4] Assets at the end of first half of 1986

All conversions at $1 = 870 won
*Table shows all of the major electronics firms listed on the Korean stock exchange. Major unlisted companies have also been included, but the first half figures have been estimated from reliable industry sources. These are indicated with an * after the name of the company.

Source: *Business Korea*, ELECTRONIC BUSINESS

minals, 50%; export model cassette recorders, 50%; facsimiles 40%, VCRs, 35%; microwave ovens, 25%; and color televisions, 10%.

For all these items, crucial to the export success of Korea, Japan is the source of supply for almost every imported part.

The EIAK's Kim accepts that the introduction of Japanese technology is crucial to Korea. "The joint ventures with foreign companies were the basic foundation for the growth of the Korean electronics industry," he says. "Initially most came from the U.S.A., but then Japan became a more convenient place to get technology because of geographical closeness and language." But today Kim describes the surplus with the United States and the deficit with Japan as "our major concern in industry and in government. We will try our best efforts to close that gap."

Closing the gap

One company which is already doing that is Goldstar Semiconductor which is a joint venture between AT&T of the United States and the Goldstar Group. The venture makes telecommunications switches, micro- and mini- business computers and a range of semiconductors — including complementary metal-oxide semiconductor (CMOS) gate arrays of up to 10,000 gates, 1 megabit read-only memories (ROMs), 64K static random-access memories (SRAMs) and 64K dynamic random-access memories (DRAMs). General manager Choi expects sales to increase from $160 million last year to around $200 million this year. He also expects Korean semiconductor makers will benefit from the recent price fixing deal between Japan and America. "We have not, up to now, been in a profitable position," he says. "We now hope within a year to be profitable."

> In a bid to keep up, Korea's leading firms are devoting more resources to R&D

Certainly Korea's electronics majors have decided to invest heavily in semiconductor production capacity and are devoting a growing share of revenue to research and development (R&D). EIAK figures show that during 1985 and 1986, Samsung Semiconductor and Telecommunications will invest $450 million and spend $90 million on R&D for semiconductors. The equivalent figures for Goldstar Semiconductor are $215 million, with $42 million for R&D; and for Hyundai Electronics, $190 million, with $32 million on R&D. Optimistic forecasts suggest Korean firms could boost their share of the world semiconductor memory chip market to almost 10%, from 5% to 6% today.

Samsung is now making about 3 million 64K DRAMs and 3 million 256K DRAMs a month, as well as a small number of electrically programmable read-only memories (EPROMS). It recently announced the development of a 256K SRAM. Hyundai Electronics — which has only entered the field in 1983 — hopes to be offering a complete range of memory products by year's end. Its plant can make 650,00 five- and six-inch wafers a year.

In a bid to keep up, Korea's leading firms are devoting more resources to R&D. Goldstar now devotes 7% of sales revenue to R&D and Daewoo and Samsung spend around 4%. The industry average of 3.5% is high in relation to the rest of Korean industry but is still low by world standards for the electronics industry.

Korean firms are keen to develop indigenous technology in the consumer electronics area, too. The three major makers of video tape recorders — Daewoo, Goldstar and Samsung — have set up task forces to increase the locally made proportion from the current 65% to 75% within a year.

However, there are limits to the extent to which Korean firms have the resources to develop all the technology they need, and they are keen to develop links with new sources of technology. For this reason Seoul is being inudated with American and European executives. Many stay, ironically enough, in luxury hotels built with Japanese capital.

Last fall, for example, a delegation of 41 West German firms participated in a technology transfer symposium, attended by over 2,500 engineers and executives from Korean firms. The mission concentrated on the production automation, computer-aided design and manufacturing (CAD/CAM), and other factory equipment. Says the project manager in charge, Bernd Reichhardt: "The appreciation of the yen means that, at this time, the gap between German and Japanese prices has fallen. While a year ago they were typically 30% more expensive, now they are less than 10%. Many Koreans say they would prefer German machinery even if it is 10% more expensive because there is more technology transfer than with the Japanese."

In another event at about the same time, 14 French companies organized a teleconferencing event sponsored by the French Direction Generale des Telecommunications in cooperation with the Korea Telecommunications Authority and other organizations. The French firms — including Alcatel, Bull and Crouzet — discussed the latest French switching and transmission equipment and possible joint ventures.

Keen to diversify

The Korean electronics industry is keen to diversify its export markets as well as its sources of supply. Last year just 4% of Korean electronics exports went to West Germany, 3% to Britain, and 2% to France. The market planning manager at Hyundai Electronics, Soon-chun Shin, says that his company is aiming over the next few years to double the proportion of sales in Europe, from 15% to 30% of total sales and in Asia from 5% to 10%. The share of North America would fall from over 55% now to less than 45%, with a slight fall in proportion sold locally.

To underline this trend, Samsung Electronics has just announced it will invest $25 million to build a consumer electronics plant in the depressed northeast of England. By 1990, the plant will be making 250,000 VCRs, 300,000 microwave ovens and 300,000 color televisions a year for export to the European Economic Community. Samsung also has a plant in Portugal making 200,000 color TVs a year and a plant in New Jersey, making around 100,000 color TVs.

Goldstar's factory in Alabama is reported to be one of the company's most successful foreign plants — with product rejection rates among the lowest in the group and staff absenteeism at just 1%, compared with a U.S. average of 5%. It makes 500,000 microwave ovens and over 1 million color TVs a year for sale in North America and Mexico.

Goldstar has also just started construction of a factory in Worms, West Germany. It is investing $2.6 million and an additional $28 million has been raised locally. The plant is scheduled to start production next September and will have a capacity of 400,000 VCRs and 300,000 color TV sets a year.

Announced R&D activities in semiconductors

Company	Products	R&D spending ($ millions)	Change ($ millions)
Samsung	1Mb DRAM; 64K SRAM; 8-, 16-bit µC; high-performance CMOS TTL; 10K gate array	$28	No change
Goldstar	1Mb DRAM, 64K EPROM, high-performance CMOS TTL, bipolar IC, consumer IC	$23	+$19
Hyundai	1Mb CMOS DRAM, 64K EEPROM, 264K video DRAM, programmable electrically-erasable logic	$13	+$11
Daewoo	Gate array, consumer IC, power IC	$5	N/A
KEC	Consumer IC, power tranceiver, UHF tranceiver	$3.5	No change

N/A = Not available

Source: Dataquest Inc.

The approach is described by Andrew G. Grose, executive director of the Commission on Economic Development for the State of Nevada, who has just organized a mission to Korea to attract inward investment: "Korea is already talking about investing where its markets are. They don't want to get in the same bind the Japanese are in. They've learned from them."

Maybe. But U.S. trade officials are not convinced. U.S. diplomats say privately that it might be necessary to file some more Section 301 unfair trading cases against Korea to make its government realize that the United States means business.

"They continually structure their trade pattern after Japan's," adds Winship of the International Executive Service Corps. "They say: Japan was successful; so they think they can be successful ad infinitum." He argues that Americans just have to keep on battering the Koreans to open their market to imported products.

And American Chamber of Commerce head Krause reckons: "The way out is not protectionism. But there has to be legislation to promote reciprocity," he says. Krause expects the new Congress will enact trade laws to balance the books against those countries with persistent current account surpluses with the U.S. — notably Japan, South Korea, Taiwan and West Germany.

Meanwhile South Korea's electronics industry grows like Topsy.

The Ministry of Trade and Industry forecasts that electronics production and exports will keep on rising at around 19% a year over the next five years. That would mean output of $21.9 billion and exports of $13.1 billion by 1991. Those forecasts may already be outdated: the target for 1987 will be met in 1986!

The official line is described by Park Young Tahk, deputy director at the MTI: "We are not a second Japan. We are interested in long mutual benefit, not just short term profits."

But one exasperated U.S. executive sums up a mood which could limit some of Korea's fast growing export hopes: "It's nauseating to hear them complaining of protectionism in the U.S. when they do it with [such] great fervor."

Tank, a New Delhi-based business writer, recently spent three weeks in South Korea preparing this report.

Korea: A land of opportunity, or a profitless battleground?

Vibrancy of the electronics industry means business for U.S. suppliers

By Wan Hee Kim

Korea's prosperous economic outlook and its concerns about becoming overly dependent on Japanese imports present U.S. electronics companies with an excellent opportunity to do business with Korea.

U.S. companies and government officials already have been applying great political pressure on Korea to open up its domestic markets to many industrial and agricultural products made in America. Their motive is to make money from Korea's strong, expanding economy. The country's economic growth is expected to average 7.2% annually for the next five years, with its gross national product reaching $166 billion in 1991.

WAN HEE KIM

Korean manufacturers and the Korean government, meanwhile, are doing their best to reduce the country's trade deficit with Japan. It totaled a $5.8 billion in 1986 alone. They are eagerly searching for new sources of supply for technology, equipment and parts, in addition to boosting their own exports to Japan.

There is evidence of progress on at least one front. Negotiations between the U.S. and Korean governments have resulted in Korea's agreeing to revise its own patent and other laws relevant to the recognition of foreign intellectual property rights. The revised laws, which govern areas such as technology trademarks, will become effective in September of this year.

Korea also has agreed to admit American-made personal computers by July 1987 and computer peripherals by July 1988.

At the same time, the U.S. government has asked for the drastic reduction of tariffs Korea has posed on 27 items, including frozen vegetables, soft drinks, cosmetics, films and other products from the United States. Consequently, Korea has just announced its decision on the reduction of tariffs on American-produced speakers, chocolates, tennis rackets and other U.S. products, starting in 1988.

Production of small computers and related products already is booming in Korea. Manufacturers in Korea, this year, already have export orders totaling more than 1.5 million personal computers — mostly from U.S. compa-

The Japanese foothold is too strong for U.S. companies

By Young C. Kim

The electronics capital equipment market in Korea was dominated by U.S. manufacturers up until a few years ago. But an aggressive market-share approach by Japanese manufacturers, characterized by low pricing and supported by excellent service, toppled the U.S. lead. And it is highly unlikely that U.S. manufacturers can regain the ground lost to the Japanese in Korea.

The worldwide slump in semiconductor sales has only made matters worse in Korea from a U.S. manufacturer's perspective. While sluggish chip sales have produced a flurry of moves by practically all equipment makers to protect their market shares in every major region, including Korea, none has moved as aggressively as Japanese equipment suppliers. They are more protective of their market share than their U.S. counterparts. And they will do anything to keep their U.S. competitors from chipping away their market share.

YOUNG C. KIM

The chief protective measure employed by the Japanese is aggressive pricing. Their strategy is to get market share first, usually through low prices, and profits later. U.S. manufacturers, on the contrary, are more interested in making money today — profit performance is more important than market share.

The way the Japanese companies are expanding their foothold in Korea may not necessarily be profitable for now. But they certainly aim to earn money on future business. They come in cheap on current bids with the intention of making up for any losses on subsequent sales.

Pricing is not the only measure used by the Japanese. They also do an excellent job for their customers. Korean engineers claim their Japanese equipment suppliers fulfill their obligations as promised. The engineers also praise the Japanese for how quickly they react to equipment problems, saying their response time is incomparably faster than that of their U.S. counterparts. "American companies are no longer competitive whether it is price, performance or support," says one Korean engineer.

Korean electronics companies want to buy American equipment — in part to balance trade with the United

John Kilroy

PROSPEROUS OUTLOOK *(Continued)*

nies such as Computerland and Leading Edge and others. Gold Star, Samsung and other Korean computer makers also are battling foreigners for a share of their own domestic computer market. IBM and Hewlett-Packard Co. are among the 30 companies trying to sell systems to Korean businesses, which also are being pitched at heavily by Japanese computer producers.

Korean semiconductor makers, on the other hand, are coming off a tough year, when slack demand kept prices low in world chip markets. Nevertheless, they still are putting more money into research and development (R&D), and plant expansion.

Such investments may reduce Korea's reliance on foreign components. Korean electronics companies currently import more than 35% ($2.5 billion in 1986) of their component needs. Government and industry officials hope to bring the figure down to 24% by 1991.

Japan has been the chief source of foreign goods sold in Korea. More than 75% of Korea's electronics imports in 1985 came from Japan; the rest were mostly from the United States. During the 20 years between 1965 and 1985, in fact, Japan imports grew to account for 87% of Korea's $39 billion foreign trade deficit.

In 1986 alone, Korea's trade deficit with Japan was about $5.8 billion. If Japanese imports continue to grow at their current pace, they will reach $8.2 billion a year in 1990 — creating a $37.1 billion trade deficit during the five-year period. That would be larger than the deficit Korea had for the last 20 years with Japan.

Thus, the Korean government and industries are exercising their best efforts to reduce the trade deficit against Japan by searching for new sources of suppliers of technology, equipment and parts, and also by expanding their exports to Japan. This will certainly provide an excellent opportunity for American companies to do business with Korea.

Wan Hee Kim is chairman of WHK Industries Inc., a Palo Alto, California-based management consulting firm specializing in technology transfer, overseas investments and joint ventures in electronics in Asia. He also is an advisor to the Korea Electronic Industries Association, on which he has served as chairman of in the past.

Korea can't produce enough...

	Industrial products	Components
1986	$2.3 billion	$4.3 billion
1991	$6.4 billion	$8.0 billion

to keep up with exports...

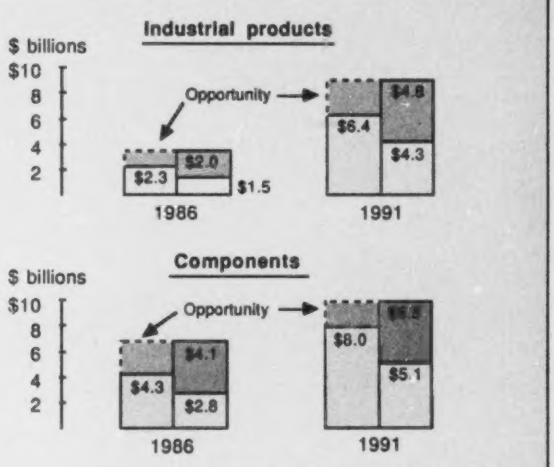
	Industrial products	Components
1986	$1.5 billion	$2.8 billion
1991	$4.3 billion	$5.1 billion

and satisfy its own domestic demands...

	Industrial products	Components
1986	$2.0 billion	$4.1 billion
1991	$4.8 billion	$6.5 billion

creating opportunities for U.S. suppliers to Korea

	Industrial products	Components
1986	$1.2 billion	$2.6 billion
1991	$2.7 billion	$3.6 billion



Source: Korea Electronic Industries Association

JAPANESE FOOTHOLD *(Continued)*

States. (The U.S. electronics trade deficit with South Korea was $1.2 billion in 1985.) But U.S. equipment manufacuturers so far have not been able to match the aggressive equipment pricing of the Japanese, leaving little choice for Korean customers. It is simply a matter of economics for Koreans to do business with Japanese manufacturers.

No one — except the customer — is making money under these circumstances. Market-driven price competition does not and will not generate a normal profit unless manufacturing costs are brought under control — a daunting task in its own right. Controlling the costs of making capital equipment entails automation of manufacturing processes, which takes investment and time, as well as other productivity and inventory improvements. That is a tall order, especially for U.S. companies.

Over the years, U.S. industry has witnessed the erosion of its market share in textiles, steel and automobiles under the forces of foreign competition, mostly Japanese. The U.S. semiconductor industry may be next.

The United States, however, cannot afford to let foreign competitors take away the livelihood of its high-technology industry. It can no longer blame the Japanese for the astronomical deficit figures that seem to grow every month that they are announced.

Ready or not, the U.S. electronics industry is in the midst of a global trade war where old military strategies just will not work. The United States must arm itself with new strategies, ones that will endure the severest of competition — in Korea or on its own shores.

Young C. Kim is vice president of finance for Pacific Western Systems Inc. in Mountain View, Calif., which makes wafer probers, memory testers and vapor deposition equipment. Kim also serves as president of Pacific Western's Far East operations.

Semiconductors: The year of living dangerously

Consolidation, alliances, fickle markets and trade pacts have reshaped the chip business. There is more to come

By Alden M. Hayashi

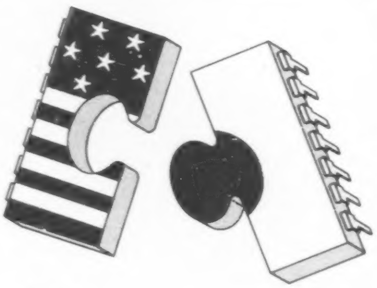
1986 was an eventful year for the leading worldwide semiconductor companies. The proposed Fujitsu acquisition of Fairchild and the Toshiba joint venture with Motorola highlighted the industry's move toward consolidation and alliances among the top players. The U.S.-Japan semiconductor trade pact agreement forced many companies to revamp their corporate strategies. And major swings in exchange rates shifted the competitiveness of companies doing business in foreign markets.

Perhaps the most intriguing event of 1986 was Fujitsu Ltd.'s announced intention to purchase 80% of Fairchild Semiconductor Corp. The proposed acquisition would move Fujitsu a few notches up from its current ranking of the sixth largest semiconductor vendor in the world. And the Fujitsu-Fairchild alliance would dominate the emitter-coupled logic (ECL) chip market with a worldwide share of nearly 50%.

Furthermore, the acquisition would propel Fujitsu to at least twice the size of any other Japanese semiconductor company doing business in the United States, says Wilfred J. Corrigan, chairman of LSI Logic Corp. of Milpitas, Calif. By buying 80% of Fairchild, Fujitsu also would have access to the various U.S. independent distributors which up until now handled few Japanese chips. If the acquisition is approved by the U.S. federal government, other Japanese corporations will attempt similar buys of U.S. companies, claims Corrigan. "It will have a domino effect," he warns.

Corrigan is not alone in his concern. Speaking at a luncheon for the New York Society of Security Analysts, Jerry R. Junkins, president and chief executive officer of Texas Instruments Inc., headquartered in Dallas, called this possible trend of Japanese buyouts "a bit disturbing." But, he added, "I wouldn't comment on whether it's the beginning of many or whether it's one of the few."

More palatable to U.S. companies was the announcement late last year of a joint venture between Toshiba Corp. and Motorola Inc., respectively the third and fourth largest semiconductor suppliers in the world. The venture calls for the establishment of a joint manufacturing operation in Japan where Toshiba will supply its memory chip expertise while Motorola transfers its microprocessor technology. Thus Toshiba gets to strengthen its weakness in microprocessors while Motorola gains memory-chip prowess. "We definitely have a need for the Motorola technology," says Bob Brown, a vice president of Toshiba America Inc. in Tustin, Calif. Motorola also gets to use Toshiba's memory chip know-how to start manufacturing dynamic random-access memory (DRAM) chips in the United States again. Several years ago, Motorola bailed out of the DRAM market because of aggressive competition from the Japanese companies.



1986 was an eventful year for leading semiconductor companies

Analysts call the joint venture a "win-win" situation. "Both companies basically got what they needed," says William J. McClean, analyst with Integrated Circuit Engineering Corp. (ICE), a market research firm located in Scottsdale, Ariz. Even competitors of Motorola and Toshiba cannot fault the alliance. "It's very hard to find anything wrong with the partnership at this time," says William Gsand, a vice president for Hitachi America Ltd. located in San Jose, Calif.

However, 1986 also marked the undoing of the RCA-Sharp joint venture, a partnership whereby both companies were to establish a joint manufacturing facility in the United States. General Electric Co., after purchasing RCA Corp., cancelled RCA's deal with Sharp Corp. Says ICE's McClean: "Somebody should pick up the ball on that." McCleans adds that "it could be a tremendous deal" for a company such as Advanced Micro Devices Inc. or National Semiconductor Corp.

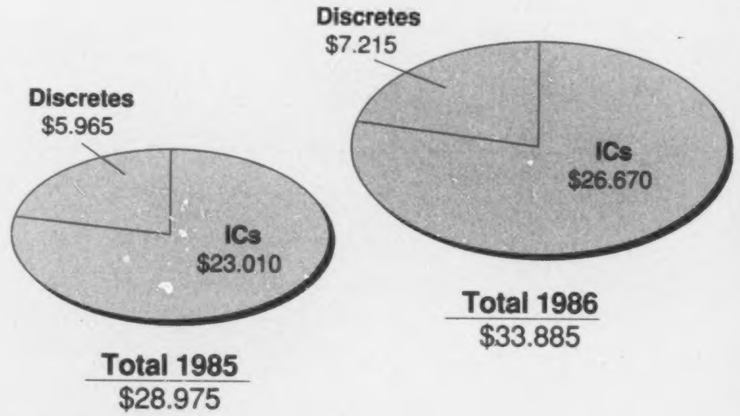
McClean contends, "These types of deals and associations are going to be critical. The future is going to depend on strong alliances." Others agree. William Sick, formerly in charge of TI's semiconductor operations, explains that chip customers now want to do more of their business with a fewer number of suppliers in order to cut down on costs. Thus, says Sick, customers will choose those suppliers with the most diversified and complete product lines. And in order for suppliers to broaden and fill their product offerings, alliances are all but required, according to James Norling, an executive vice president of Motorola. "I don't see how one guy can cover the whole waterfront by himself," says Norling.

Toshiba's Brown adds that as the semiconductor industry continues maturing, competition continues intensifying. And with fiercer competition, leadtimes (the time between when a company first introduces a new product versus the time its competitor introduces a similar product) have shortened. As a consequence, companies are now finding it difficult to recoup their research and development (R&D) investments because they can no longer charge, for any substantial period of time, premium prices for new products, says Brown. So by working with their competitors, companies can then mitigate their R&D costs.

Alliances are also an effective way to penetrate foreign markets. For example, Toshiba reportedly will aid Motorola in the latter's efforts to sell into the Japanese market. Toshiba's help will be welcomed by Motorola which, for years, has had difficulty gaining a strong foothold in Japan.

Worldwide semiconductor production*

($ billions)



1986 figures are estimates
*Includes captive manufacturers such as IBM

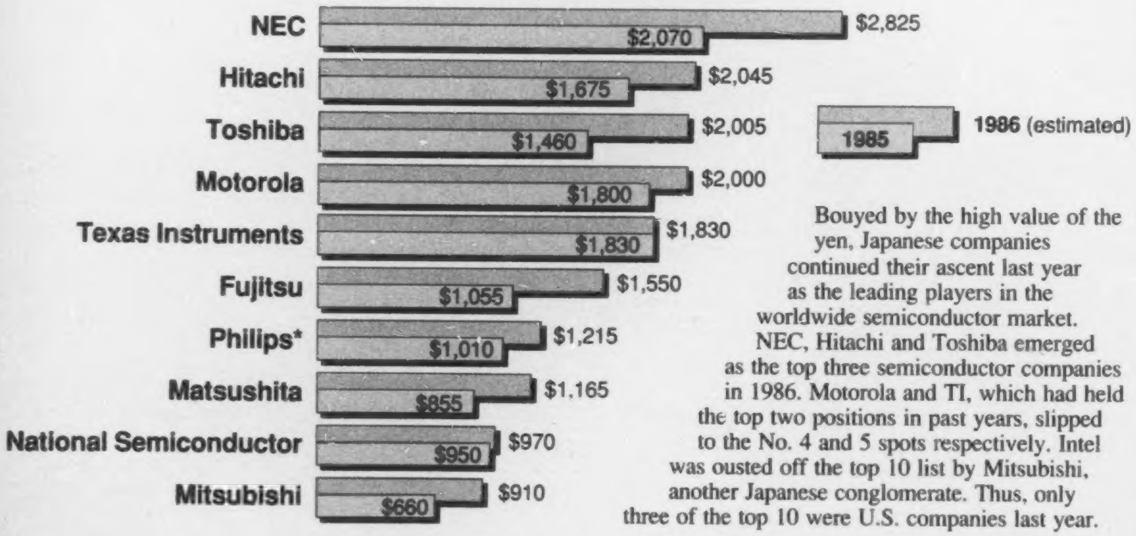
Source: Integrated Circuit Engineering Corp.

Prowess in international markets will be necessary in the future, according to the ICE's McClean. "The producers that will do well are the producers that have a presence in Europe, Asia and the United States," he says. "I remember that just a couple years ago Intel [Corp.] said they saw no reason to put up a facility in Japan. That attitude has got to change."

It will, say many who see more competitive collaborations, such as the Toshiba-Motorola partnering, and more acquisitions, similar to the proposed Fujitsu-Fairchild buy-out, occurring in the future. "Only the tip of

The top 10 semiconductor companies

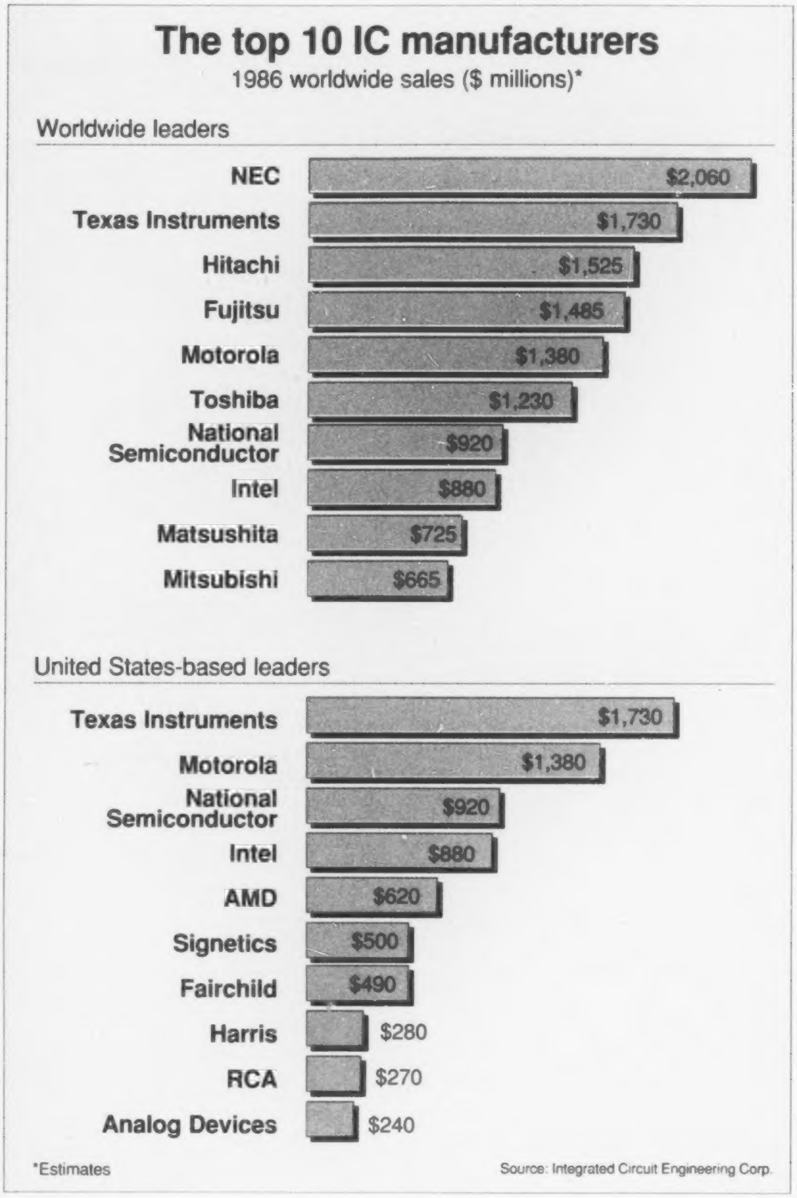
Worldwide sales ($ millions)



Bouyed by the high value of the yen, Japanese companies continued their ascent last year as the leading players in the worldwide semiconductor market. NEC, Hitachi and Toshiba emerged as the top three semiconductor companies in 1986. Motorola and TI, which had held the top two positions in past years, slipped to the No. 4 and 5 spots respectively. Intel was ousted off the top 10 list by Mitsubishi, another Japanese conglomerate. Thus, only three of the top 10 were U.S. companies last year.

* Includes Signetics

Source: Integrated Circuit Engineering Corp.



The top 10 IC manufacturers

1986 worldwide sales ($ millions)*

*Estimates

Source: Integrated Circuit Engineering Corp.

the iceberg has been seen," asserts Toshiba's Brown.

Trade pact fallout

More alliances will occur in the future also as a result of the U.S.-Japan semiconductor trade pact agreement which was reached last summer. As a consequence of the agreement, Japanese companies are now more interested in increasing their manufacturing operations in the United States in order to avoid the price floors that the United States has set on certain chips that are manufactured on non-U.S. soil, thus Fujitsu's appetite to acquire Fairchild. At the same time, U.S. companies are interested in increasing their manufacturing presence in Japan in order to capture a greater share of the market there, which the Japanese government has promised, thus Motorola's partnership with Toshiba.

Because of the price floors, some Japanese companies are no longer competitive when selling certain chips in the United States. The yen's recent appreciation also has hampered Japanese companies by making their products more expensive outside of Japan. Indeed, says Toshiba's Brown: "We are effectively not selling any 256K DRAMs in the U.S. today. And basically our EPROM [erasable programmable read-only memory] business has gone to zero. The Japanese are essentially out of that market in the U.S."

But the semiconductor trade pact has not hurt all Japanese companies. By using its $100 million manufacturing plant in Roseville, Calif., NEC builds chips in the United States which are not subject to the price floors. "Roseville gives us a tremendous advantage," says Henry Josefczyk, a senior vice president for NEC Electronics Inc., headquartered in Mountain View, Calif. And because other Japanese companies do not have full manufacturing capabilities in the United States, Josefczyk adds: "The trade pact, to some degree, has had a favorable effect for us." NEC is planning to invest an additional $600 million to expand its Roseville facility by 1990.

The loss of business by Japanese companies in the United States has not been beneficial to all U.S. companies, many of which left the mainstream memory-chip markets years ago. To date, only Motorola, via its joint venture with Toshiba, says it will be reentering the DRAM market. "The trade agreement has sort of closed the door after the horse has left the barn," says Hitachi's Gsand.

Korean companies, particularly the Samsung Group, have taken advantage of the trade pact by selling chips in the United States at prices below the fair market values (FMVs), or price floors, set for the Japanese companies. "Somebody ought to apply dumping charges against the Koreans," says NEC's Josefczyk. He cites the pricing of the 256-kilobit DRAM, a workhorse memory chip of the industry, as an example. Although the lowest FMV is $2.50, one Korean company is selling that chip at a price below $2, asserts Josefczyk. Hitachi's Gsand estimates that Korean companies had no more than 2% of the U.S. 256K DRAM market a year ago. Today, the Korean companies now control from 10% to 20% of that same market, contends Gsand.

In addition to benefiting the Korean companies, the implementation of price floors in the United States has also made the gray market more active. Motorola's Norling says that for some types of chips, "we believe that the business that is being placed, is being placed in the gray market at below FMV prices." ICE's McClean

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If Fujitsu had bought Fairchild in 1985...

	Combined sales ($ millions)	Worldwide market share
Semiconductors	$1,512	6.2%
ICs	1,391	7.5%
Bipolar digital	596	15.9%
TTL	268	8.7%
ECL	323	47.5%
Other	5	12.7%
MOS	653	6.5%
Memory	416	10.8%
Micro devices	116	4.3%
Logic	121	3.4%
Linear	142	3.0%
Discretes	76	1.6%
Opto-electronics	45	3.7%

Source: Dataquest Inc.

says that the recent gray market price for one 256K DRAMs was between $1.75 to $1.90, significantly below the lowest FMV of $2.50. McClean adds that many Japanese companies are selling their chips in Japan to brokers who specialize in the gray market. Sometimes, McClean says, the chips will be sold six times before leaving Japan, making it difficult to trace their origin.

The trade pact has opened up market windows for some companies. ICE's McClean explains that although Toshiba was first selling 1Mb DRAMs, the company could not leverage its pioneering position. Usually, companies which are first with a new product have an advantage in that they are able to lower their pricing as they ship greater volumes. But because of the trade pact, Toshiba has not been able to drop its 1Mb DRAM prices quickly, says McClean. According to him, the price of a 1Mb DRAM chip should have been around $10 now. But because of the FMV price floors, 1Mb DRAMs are selling for around $20 each. As a result of prices decreasing slower now, Toshiba's competitors have an extra six months to a year to enter the market, says McClean.

When the trade pact agreement was first arrived at last summer, critics foresaw an exodus of electronics manufacturing from the United States to the Far East where chips would be cheaper. "The trade pact has made our U.S. customers say: 'If I have to purchase chips in the U.S. at higher prices, it's going to affect *my* competitiveness,'" says Toshiba's Brown. Adds NEC's Josefczyk: "We recently saw a customer, whose business to us was worth over $1 million a year, move his manufacturing totally to Hong Kong."

Hitachi's Gsand says that most of his larger U.S. customers that already have plants offshore have begun to shift more manufacturing there. Those companies had the flexibility to react quickly, says Gsand. On the other hand, small and medium-sized companies, many of which do not have factories offshore, were not so fortunate. These companies are now in the process of considering the move to the Far East, contends Gsand. According to Toshiba's Brown, a key question for those U.S. customers is: How fast will the U.S. government lower the FMV prices? The U.S. government has been reviewing and revising the FMVs on a quarterly basis. Brown adds that unless the FMVs decrease significantly, those U.S. companies will be moving their manufacturing offshore. ☐

Selling VLSI equipment in Japan tests U.S. vendors

U.S. test equipment makers have been singularly unsuccessful selling VLSI testers in Japan. So why do they persevere?

By Mark Mehler

In the last 2.5 years, U.S. suppliers of automatic test equipment (ATE) for very large scale integrated (VLSI) logic circuits have sold a grand total of one new-generation machine into the Japanese market — that being Trillium Corp.'s sale of a 256-pin, 60-MHz Arraymaster system to Mitsubishi Electric Corp. last year.

The failure, however, of American companies to unseat Japan's domestic VLSI test equipment suppliers — Advantest Corp. and Ando Electric Industrial Corp. — in that country has not yet proved disastrous. Last year, Japan only accounted for 29% of the $410 million worldwide market for VLSI testers, according to VLSI Research Inc., a market research firm in San Jose, Calif. The chief reason is that Japanese semiconductor companies, the country's chief customers of test equipment, have traditionally focused their efforts more on producing memory and other high-volume parts than on making VLSI devices.

Nevertheless, such U.S. hopefuls as Trillium (a subsidiary of LTX Corp.), GenRad Inc., Megatest Corp., Schlumberger Ltd.'s Sentry Test Group and Teradyne Inc. are currently battling for even the tiniest toehold in Japan. Why? "Japanese chip makers are getting serious about competing in application-specific ICs [ASICs] and other semicustom and custom parts," offers G. Daniel Hutcheson, president of VLSI Research. Those types of semiconductors require high-speed VLSI designs.

"There are good reasons to believe they [the Japanese] won't succeed, since flexible design and test software are the issues. And the U.S. still has

Marty Braun

the edge there," Hutcheson says. "But if they are successful, Japan should [represent] 45% of the worldwide VLSI tester market by 1990. No VLSI test equipment supplier will be able to ignore Japan and stay in business."

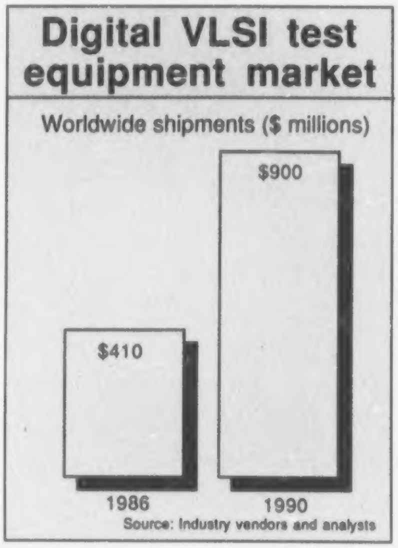
Aside from the potential dollars involved — the worldwide digital VLSI tester segment is expected to reach nearly $900 million by 1990 — this technology drives every other segment of the ATE industry. Thus, if the loss of Japan quickens a U.S. shakeout from the high-end logic test market, then it won't be long before America's dominant positions in testing linear ICs and printed circuit boards will come under pressure.

Hutcheson believes some U.S. companies, notably Trillium, bring something new and exciting to the Japanese VLSI tester market — specifically the ability to perform reliable tests on complementary metal-oxide (CMOS) chips. But neither he nor anybody else underestimates the awesome sales job facing foreign VLSI test equipment vendors. Some are calling it mission impossible.

"It's utterly futile," argues James Bowen, president of Attain Inc., a linear tester manufacturer in San Jose. "Ando and Advantest have worked closely with users since the late 1970s. Now, after eight years, U.S. companies are saying, 'We're back,' and the response is: 'So what?'"

The only time a Japanese electronics company buys a foreign product is when there are no suitable alternatives in Japan, Bowen says. Schlumberger and GenRad had their chances, he notes. If Sentry had been able to execute years ago on the (high-end) Series 50, or if GenRad had not missed the window back in 1981, it would have been different. "As it is," Bowen says, "even a U.S. vendor with a truly unique machine has an uphill fight."

Jay Cooper, an analyst with Eberstadt & Fleming Inc. in New York City, says that it is much too early to look for major sales of U.S. VLSI testers into Japan. "A few heads are turning in the user community there, but the prejudice against U.S. equipment is strong," says Cooper. He believes that it will take at least two to three years for American vendors to convince Japanese customers that they are in the business to stay.


Digital VLSI test equipment market

Source: Industry vendors and analysts

Adds another pessimistic observer: "When Advantest started shipping 100-MHz systems six years ago, it created a perception of Japan as the technology leader. Actually, their systems are faster and they never go down, but historically, U.S. equipment has better system accuracy, better ability to operate at low machine capacitance for CMOS, and easier to use applications software. Despite all of that, the Japanese vendors seem to have things pretty well sewn up. Maybe a U.S. company that can differentiate its product can manage to confuse enough people to sell a few systems."

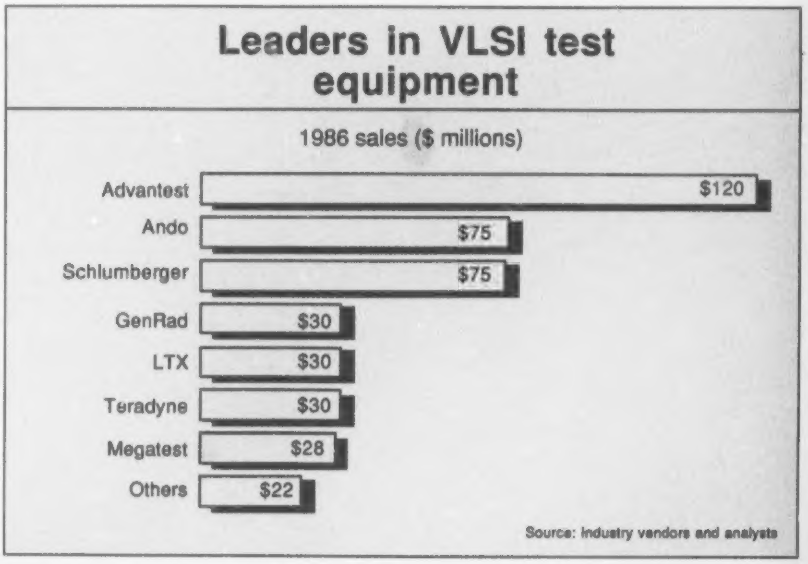
Vendors are optimistic

James Healy, the president of Trillium, agrees that leading-edge system architectures impress Japanese customers. His company, for example, touts its tester-per-pin construction, in which each test pin has its own memory, timing and formatting capability. However, Healy believes two other factors will weigh far more heavily on the future of U.S. VLSI testers in Japan.

"Because Japanese customers always want you to do some hardware or software modification, like adding a little higher current, you have to have full engineering resources there," insists Healy. "Second, when the Japanese plan a multimillion-dollar tester buy, they always look ahead. You have to show them the future. Most of all, you need a stable organization. We have 70 of our own people in Japan, and we think we have the required design capability over there."

The Trillium president sees some 90% of Japan's VLSI tester market as open to foreign suppliers willing to commit resources. He willingly concedes the other 10% to high-speed Japanese equipment optimized to test custom and semicustom parts that go into mainframe computers. Healy, in particular, believes U.S. test equipment vendors stand a fair chance of cracking second-tier accounts such as Ricoh Ltd. and Sony Corp., companies with growing in-house semiconductor operations. "They previously depended on large merchant IC makers, but now the systems people [at those companies] are doing more design work of their own and may be open to buying American equipment."

Teradyne executives contend that the key to success in Japan is selling a full ATE product line. Edward Rogas, vice president and general manager of Teradyne's Semiconductor Test Group in Woodland Hills, Calif., says


Leaders in VLSI test equipment

Source: Industry vendors and analysts

ATTENTION VENTURE CAPITALISTS

ELECTRONIC BUSINESS magazine is preparing its annual directory of venture capital firms. We need your assistance to make sure the directory is timely and accurate. If you are a venture capitalist, or work for a venture capital firm, please fill out the following form and return it to us by April 1. Mail to:

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that Japanese customers care more about prices and vendor stability than about pure system specifications. In addition to its Japanese installed base of memory, linear and backplane testers, Teradyne has sold several older 941 VLSI machines in that country and has a line of VLSI systems priced from $500,000 to $3 million.

"We've got organizational strength with our own company [Teradyne KK] in Japan staffed by 200 Japanese nationals," boasts Rogas. "This is what users need to see. Certainly we expect our J953 per-pin system to compete with Advantest for the high-pin-count 32-bit, RISC [reduced instruction set computer] chips, but for 140-pin ASICs, you don't need all that capability."

Role of trading partners

Neither Megatest nor GenRad operates in Japan through its own subsidiary. Megatest is represented by Japan LSI, and GenRad has a joint marketing venture with Tokyo Electron Ltd. Both vendors insist, however, that having a Japanese partner is the best way to gain credibility.

"JLSI gives us enough of an engineering base there," says Richard Carmichael, sales director of San Jose-based Megatest Corp. But he concedes that the $34 million company has a difficult task persuading Japanese users that Megatest will be around for awhile. The task is even harder when Megatest is compared with companies such as Teradyne that are much older and bigger and with companies like LTX that have demonstrated in Europe that they can service a foreign market.

"We are told repeatedly that they feel our per-pin system matches all their dreams and desires for easy to write software for CMOS gate arrays, ECL [emitter-coupled logic] and MPUs [microprocessor units]," says Megatest's Carmichael. "But do they have faith in our longevity? . . . That's a key problem for us."

It is not a problem for GenRad, which has installed 100 VLSI testers worldwide. "I have found that having a healthy installed base is a very important advantage in Japan," says Gene Roth, marketing manager for GenRad's Semiconductor Test Division in Milpitas, Calif. GenRad, a few years ago, sold a couple of its older VLSI machines, the Models 16 and 18, to Hitachi Ltd. and Oki Semiconductor. And Roth believes the relationship with TEL gives GenRad sufficient application support to sell the new 60-MHz Model 180 to Japanese ASIC and 32-bit microprocessor manufacturers.

Schlumberger's Sentry unit is widely seen by analysts as the least likely of the U.S. entrants to make a mark in Japan because its flagship VLSI test product, the Model 50, was late to market and built on what some regard as an old tester architecture. The company, similar to GenRad and Japanese test equipment vendors, offers a conventional shared-resource system in which tester channels share memory and formatting functions. A Sentry spokesman, acknowledging that the Model 50 was delayed several years, argues that Japanese users have been comfortable with conventional architectures and are unlikely to gravitate to the newer per-pin systems en masse. The Sentry source further insists that the company's direct sales presence in Japan proves that they are giving serious attention to that market.

Other factors in U.S.'s favor

Japan's currency woes, also, could act in favor of the U.S. VLSI test equipment vendors. The appreciation of the yen against the dollar has made American-made equipment cheaper to buy in Japan. The yen's rise also has accelerated plans by Japanese electronics companies to move some production outside of Japan. As more and more large Japanese companies shift production to offshore sites, securities analyst Cooper reasons, more tester-buying decisions could be made in such places as Korea and Taiwan where prejudices against U.S. equipment are not so powerful. Of course, it will be many years before other Asian countries are far enough along the learning curve to make use of sophisticated VLSI logic testers.

Finally, some words of hope come from Kenneth Van Egmond, supervisor for test applications for VLSI Technology Inc., a Silicon Valley ASIC manufacturer that recently committed to Megatest's MegaOne. Van Egmond suggests that in their home market, at least, U.S. VLSI test equipment vendors have a lot going for them. "For us, it was a matter of establishing working relationships. We looked at Ando, which is opening a software center here, but the hardware is over there. In terms of offering links to CAE [computer-aided engineering], we also don't see Japan moving very fast. Keeping it within the local community is still an important consideration in the U.S." ☐

The bottom line on tax reform

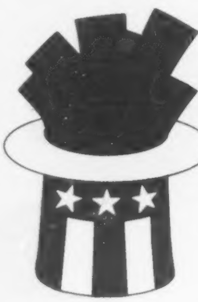
Corporate America will pay for tax reform, but with careful planning in 1987 there are ways to lessen adverse effects

By Bruce C.P. Rayner

Simplification, fairness and efficiency were the primary goals of Congress when it set out to revamp the tax code last year. But when the smoke cleared, simplification was nowhere in sight and fairness had been compromised for expedience and revenue neutrality. As for efficiency, it is still too early to say, but both economists and accountants do expect business decision making to be based more on economic rates of return than on tax breaks.

Tax experts say that for businesses, the two most important positive consequences of the Tax Reform Act of 1986 will be the lowering of the top corporate tax rate from 46% to 34%, as of July 1, 1987, and the three-year extension on the research and experimentation (R&E) tax credit (the latter being particularly relevant for many segments of the electronics industry). These advantages are, however, offset by a host of disadvantages. The more significant of these are the increase in the capital gains tax rate from 20% to 28% making it equal to the new top individual tax rate; the repeal of the investment tax credit (ITC), a credit of between 4% and 10% on certain property; and the lowering of the R&E tax credit rate from 25% to 20%. Other negative effects include: the alternative minimum tax (AMT) that requires an additional set of books to be kept; changes in employee compensation packages; and changes in the tax structure for some foreign assets and subsidiaries.

How the Tax Reform Act of 1986 affects the electronics industry depends on the specifics of the company in question, but experts agree that high tech came off pretty well. However, some changes in the way business is conducted could take place, especially for capital-intensive companies like semiconductor manufacturers. The increased cost of capital is caused mainly by the higher capital gains rate and the repeal of the ITC. The capital gains rate increase raises the cost of equity while the repeal of the ITC raises the cost of plant and equipment. For capital-intensive companies this means either postponement of investment or buying equipment offshore. It also means that leasing equipment is now more expensive.



Experts agree that high tech came off pretty well

For start-up companies and research and development firms, venture capital will be harder to come by.

For noncapital intensive companies, such as software companies, tax reform is generally favorable and certain provisions benefit start-up companies as well. The lower corporate tax rate, the extension of the R&E tax credit and other provisions — like the exclusion of software revenue of "active software companies" from classification as personal holding company income and the exclusion of research spending as a tax preference item — are all positive changes.

Coopers & Lybrand, one of the Big Eight accounting and tax firms, believes that military contractors will be the hardest hit of all high-technology segments. New accounting rules will no longer allow contractors to postpone their total tax payments until completion of the project. Now, only 60% of the tax can be deferred, with the remaining 40% due in the year the income is earned.

Steven Burrill, chairman of the high-technology group of Arthur Young, the international accounting, tax and management consulting firm, is optimistic. He downplays the impact that the lower R&E tax credit; the higher capital gains tax; and the repeal of the ITC will have on electronics companies. The R&E credit is still in place, he says, and the lower rate is inconsequential because of the now-lower corporate tax rate it must offset.

As for the higher capital gains rate, in the past there was a strong incentive to invest because the capital gains tax was 30 percentage points lower than the top individual tax rate of 50%. Now that the two are both 28%, the tax advantage has been removed and the only rationale for venture capitalists is economics. However, Burrill does not expect capital formation to be much affected by the change in the capital gains tax rate.

"The loss of the ITC to technology companies is of some concern," Burrill says, "but to a large extent the technology companies are less capital intensive, except the big semiconductor manufacturers, than other aspects of the American economy." It is the ailing semiconductor segment of the market that has many in the electronics industry worried, and tax reform is only another complication.

But Dataquest Inc., the San Jose, California-based market research firm, found in a survey of semiconductor manufacturers that their investment plans would not be affected by the repeal of the ITC, perhaps because of their other woes. Similarly, the market research firm reported that computer equipment makers do not see the new tax bill adversely effecting their business in any significant way.

Based on the survey, Dataquest concluded that although the repeal of the ITC will not stop investment, it will influence where that investment is made. "In keeping with a shift in the economic center of gravity toward the Pacific, large capital investments will more likely be made in Penang, Singapore, and Seoul, than in Santa Clara, Austin and Kokomo," says the Dataquest report.

Erosion in manufacturing

But not all are as positive as Burrill and Dataquest: "Given the tax reform environment, and many other [economic] factors, there is not a great deal to be optimistic about in terms of the [international] competitive situation for either the high-technology industry or its customers," says Ray Stata, chairman and president of Analog Devices Inc., the Norwood, Massachusetts-based manufacturer of components and subsystems. Stata is worried that, because of the shift in the tax burden from the individual to the corporation, the international competitive position of American manufacturing will be further eroded.

Stata insists that his company will not fare too badly under the new tax bill, but, at the same time, he expects the economy to suffer as a result of lower corporate savings rates that lead to lower levels of investment. Without adequate national savings, much of which is done at the corporate level, a much needed increase in investment is just not possible. "It is clear enough," Stata says, "that we are in an unsustainable mode in terms of both the [federal] borrowing and the trade deficit. There is nothing about this tax package that will do anything other than make that worse."

Some critical comments on tax reform

Anthony Spohr, Price Waterhouse: "In my view, this whole thing was thrown together in such a rapid fashion, with such an incredible fixation on reduction in rates without any real assessment of the total implication of all these changes."

Jay Yost, Coopers & Lybrand: "I think my clients are concerned that the tax laws change every other year. What we need is some stability in the tax laws so we can understand what the tax consequences are and then adjust our business accordingly. What we need most of all is certainty."

Ray Stata, president, Analog Devices: "It is clear that we are in an unsustainable mode in terms of both the borrowing and the trade deficit and there is nothing about this tax package that will do anything other than make that worse."

The Department of Commerce, in its December 1986 survey of planned new plant and equipment expenditures, paints a dismal picture of expected capital investment (but not necessarily as a result of tax reform). Manufacturing as a whole is expected to spend $141.95 billion for new plant and equipment in 1987, 2% less than in 1986. The electrical machinery segment is more healthy at a 5% planned growth rate in 1987, up from an 8.5% decline in 1986.

Weighing up the pluses and minuses, most economists are not quite as pessimistic as Stata in their expectations of the effects of tax reform. Many predict that the economy will not be too badly jolted by tax reform in the short run. However, for the longer run, concern over a worsening federal deficit and a deepening national debt are very real.

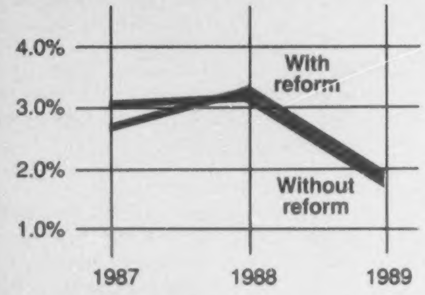
Lester Thurow, an economist at the Massachusetts Institute of Technology (MIT), does not expect any perceptible change in either interest rates or GNP growth as a result of tax reform over the next few years. But when asked whether he thought the bill would be revenue neutral, (that is, there will be no net gain in revenue over the long term) as Congress expects, he says, "Don't believe it for a minute."

The bill loses money for two reasons, Thurow says: First, revenue increases in the first year (1987) but then will decrease in the next four years; and second, he thinks that Congress has "grossly overestimated" how much revenue they are going to get by closing some tax loopholes. "If you think about balancing the budget in 1990," Thurow says, "you've got a bigger problem than you do under the current law." In total, Congress expects to raise an extra $122 billion over the next five years.

As for capital formation, Thurow

What to expect: The short-term forecast of tax reform

Real GNP growth
(Annual percentage growth)



Effects of tax reform:

Year	GNP with reform	Capital equipment spending with reform	High-quality corporate bond rate	
			with reform	without reform
1987	0.4% lower	2.8% lower	8.15%	8.60%
1988	0.3% lower	4.9% lower	8.69%	8.94%
1989	0.2% lower	5.1% lower	8.39%	8.68%

Source: Data Resources Inc.

predicts it will be a little lower under the new tax code. But what is lost in quantity of capital investment, he says, will be made up for in quality of investment. "We've been wasting a lot of capital in real estate developments we didn't really need and so if they go down, no great loss," he adds.

Nigel Gault, a senior economist at Data Resources Inc., agrees with Thurow about a lower level of capital formation but differs on both GNP growth and interest rates. He sees both as being slightly lower under tax reform. However, Gault supports Thurow's view that, in the long run, the federal budget deficit will be made worse by tax reform as a result of a failure to meet projected revenue goals. Gault believes that Congress failed to account for economic structural change when it calculated expected tax revenue for the next five years.

Senior tax manager at Price Waterhouse in San Jose, Anthony Spohr, agrees with Gault: "When people realize what they are up against, they are fairly inventive and ingenious. They will figure out ways to live with it all [tax reform], but it will take a fair amount of restructuring in order to be able to do that," he says. Although many corporate tax consultants were frantically recommending changes to their clients that should have been made by the end of 1986, there are still many adjustments that can be made in 1987 and beyond.

S corporations

One recommendation that many of the Big Eight suggest to their corporate clientele, is to opt for a Subchapter S election. Unlike a regular corporation that will be taxed at a 34% maximum rate on corporate income before distribution, an S corporation, as it is called, is taxed only once at the shareholder level at a maximum individual tax rate of 28%. Because it is the first time in history that the individual tax rate has been lower than the corporate rate, electing S corporation status makes a lot of sense. Because of the lower tax rates that S corporations have to pay, the revenue-generating potential of tax reform might not fulfill Congress's expectations. In that case, assuming a Gramm-Rudman budget environment, across-the-board budget cuts would be required.

But there are limitations to electing S corporation status: only companies with less than 35 shareholders; no more than 80% ownership in a subsidiary; no nonresident foreigners as shareholders of the company; and only one type of stock can take advantage of this corporate structure.

There are some additional costs of converting to S corporation status after the end of 1986, but many believe that it remains a good deal *if* a company can qualify. Charles Hutchinson, president of the Massachusetts Association of Public Accountants, and president and tax partner at Beers and Company Inc., thinks that it will still be a desirable adjustment in the coming years. "This Sub S movement is far from over," he says, "I think it has only begun."

ANALOG DEVICE's STATA: "We are out of step with the savings rate that it takes to produce the investment in productivity we need"

Bryce Flynn/Picture Group

How many companies opted for S corporation status in 1986, no one seems to know. The Internal Revenue Service (IRS) claims it will not know until early 1988 and no one else is willing to hazard a guess. As for tax consultants, Spohr, at Price Waterhouse, says he sees a lot of high-technology companies talking about it, but few following through.

The AMT advantage

Another advantage of electing S corporation status is that under tax reform, they are not subject to the 20% AMT rate. The new alternative minimum tax, an incredibly complex calculation, is based on taxable income plus certain deductions and deferrals and certain tax preference items. If this exceeds the regularly calculated tax, the company pays the higher of the two.

"The harder you try to save taxes by reducing your regular tax liability," says Spohr, "the more you aggravate your exposure to the alternative minimum tax." The result is that a company might end up paying more under the AMT than under the regular calculation.

The AMT will not affect high-technology companies any differently than other companies. But one area that will have to be examined carefully is in the calculation of book untaxed reported profits (BURP) adjustments. That is, 50% of the difference between book and taxable income will have to be included in the adjustment for AMT. In the past, Spohr says, accountants have worked hard to try to make the gap between financial statement income and taxable income as wide as possible. But now, "the harder we work, the behinder we get," he quips.

Another little-known fact about the AMT is that all corporations (excluding S corporations), whether they are subject to the AMT or not, will have to calculate it in order to determine their contribution to a new Superfund tax — a 0.12% tax on corporate alternative minimum taxable income in excess of $2 million slated to be used to clean up the environment. As indicated by Harvey Fireman, senior tax manager at the Boston office of the accounting firm of Ernst & Whinney, the new Superfund, not a part of tax reform, is effective for all tax years after 1986.

For example, if a corporation had income of $12 million, the tax would be $12,000. "Twelve thousand in relation to $12 million is not all that great a deal, but the record keeping burden to get there is pretty significant," comments Fireman. As spelled out in Ernst & Whinney's tax notes of last October: "This new [Superfund] tax is imposed whether or not the corporation is subject to the alternative minimum tax, and whether or not it produces toxic waste."

Rewards for labor

One area of tax reform that might affect electronics more than other industries is employee compensation. Now that the capital gains tax rate is equal to the individual income tax rate, the advantage of payment in equity, such as stock options and profit sharing, is less desirable. "I tend to think people will want more cash," says Fireman. For smaller start-up companies, this could put pressure on an already tight cash flow, and in some cases disqualify some companies from attracting top grade people.

But Fireman believes that people will still be attracted to high-tech investment because of the stock, despite the less desirable tax incentives. But an executive's decision to join a company will now be based more on economic than tax considerations.

"I think every high-tech company has to review its compensation plan now to see how it fits under the new tax law," says Jay Yost, a Boston-based tax partner with Coopers & Lybrand. "Pure equity-based compensation plans may not make sense any more." One victim of tax reform is the incentive stock option (ISO), the issuance of stock to employees as payment. Because of the higher capital gains rate, says Yost, "ISOs lose a lot of their appeal."

Furthermore, Fireman points out that the Financial Accounting Standards Board (FASB) is considering proposing a rule that would affect the income statement of companies issuing ISOs. On the day the company issues the ISO, says Fireman, the company would have to expense the difference between the present value of the projected stock price and the issuing price. As a result, ISOs would become more complex to issue. Fireman says the considered proposal might be up in front of the FASB in the first half of 1987. But industry is fighting hard to kill it, he says.

"For a small company struggling to make it, [the FASB proposal] is going to depress earnings. The consequence of that is the possibility of not being able to attract private capital, maybe not being able to do a public offering and not being able to qualify for any kind of debt from banks. Basically, it is an unfavorable result that could kill ISOs," says Fireman.

International shocks

Tax reform may have a profound effect on how electronics companies do business overseas largely as a result of what is called the "super royalty." In the past, the IRS has charged companies a license fee on royalties from technology transfers overseas based on a one-time-value of the product being transferred. Now, Congress wants the IRS to be able to revalue the royalty, and the license fee it charges, whenever it sees fit. High-technology companies are now caught between two governments: the United States, on the one hand, wants more tax revenue from foreign income to be brought back, while the foreign government wants the income to stay in its own country.

MIT's THUROW: Revenue neutral? "Don't believe it for a minute"

I don't think it [the super royalty tax] is a very wise idea," complains Coopers & Lybrand's Yost. "Foreign countries aren't going to stand by and watch the U.S. simply take profits out of companies operating in their countries. You have companies that have enough problems anyway operating abroad, [now they are] operating under this uncertainty," he adds.

Other international issues that introduce uncertainty are the shift in relative tax rates between countries and the changes this has on the foreign tax credit (FTC) limitation — the amount of foreign taxes paid that can be credited against a company's U.S. tax liability. The United States now has one of the lowest tax rates in the world, so it could be more advantageous to have income taxed in the United States instead of overseas. It also means that, now, excess foreign tax credit could be lost.

Advice for U.S. companies doing business overseas from Ernst & Whinney's Kent Schreiner, senior tax manager in the international tax department, is to review transfer pricing policies and restructure transactions in order to take advantage of the relatively low U.S. tax rate. He thinks that U.S. companies doing business overseas should review their entire international structure in order to shift income to the United States and to other low-tax countries (such as Ireland), try to maximize the FTC limitation and to become learned in the new rules and calculations required by tax reform. The international side of tax reform, Schreiner says, will see much activity in 1987 and 1988 as companies restructure their global operations.

What long-term global effects tax reform will have is still too early to tell. But it could mean more foreign interest in U.S. plant sites, and more manufacturing onshore. On the other hand, it could trigger retaliatory action from Europe and the Far East that could introduce even more uncertainty into the international business world. ☐

What plans for 1987?

Survey of business spending on new plant and equipment*

	Change from previous year			
	Actual		Planned	
	1984	1985	1986	1987
All industry	16.3%	9.2%	-1.7%	0.9%
Manufacturing	19.5%	10.6%	-5.7%	-2.0%
Electrical machinery	27.9%	5.9%	-8.5%	5.0%
Nonelectrical machinery	14.1%	3.7%	-13.8%	-7.0%

* Survey conducted in October and November of 1986. Capital spending changes not necessarily due to tax reform.

Source: Bureau of Economic Analysis, U.S. Department of Commerce

A SPECIAL REPORT
DOING BUSINESS IN
CHINA

The fifth tiger of the Far East

China continues to import computer and electronic equipment from the West. But can it make it in the export market?

By Al Furst

This April, the government of China will start to implement a series of reforms aimed at improving the investment climate for U.S. electronics companies and other foreign investors. China's decision to offer preferential treatment to high-tech companies comes none too soon.

The bloom is off for many U.S. electronics companies which were expecting to reap a harvest in high-tech sales this year. [ELECTRONIC BUSINESS, March 15, 1986 p105]. Due to a sudden shortage in foreign exchange — too much money spent in too short a time on too many Japanese automobiles and other consumer durables — China last year sharply cut its previously proposed spending for computers, communications and other Western electronic equipment.

While U.S. electronics exports to China rose a modest 12.2% for the first nine months of 1986, compared with the first nine months of 1985, China's electronics purchases were nowhere near the staggering 50% to 100% growth rates of previous years. At the same time, overall industrial production slowed to 6% last year, from 18% in 1985.

Hardest hit in the currency crunch were Japanese computer and telecommunications manufacturers whose products became less attractive to Chinese end users as the yen soared in value in relation to the dollar. In 1986, Japan saw its market share in computers shrink to 36%, from 53% the previous year. At the same time, U.S. market share rose to 54%, from 32%, according to Roger W. Sullivan, president of the Washington, D.C.-based National Council for U.S.-China Trade, a nonprofit trade group. The Japanese also lost market share in telecommunications, Sullivan reports, primarily to the Europeans.

Ira Kirchenbaum/Stock Boston

Most major U.S. corporations appear to be committed to maintaining at least some kind of presence in China

Add to this a host of problems peculiar to China — price-gouging, an extremely high cost of living for foreign expatriates, red tape, strict U.S. export controls and the inability in many cases to repatriate profits earned on Chinese soil — and there was plenty of reason for Western high-tech companies to cut and run. In fact, a number of larger companies, including IBM, recently have scaled back operations in China.

It is difficult to make generalizations, however, because some U.S. electronics companies are still doing extremely well in China. Apollo Computer Inc., for example, sold $5 million worth of workstations on the mainland last year, partly through a original equipment manufacturing (OEM) deal with the Calma division of General Electric Co. On that basis, the company decided to expand its Hong Kong-Shanghai-Beijing operation to 20 sales and service personnel. "We increased sales by 100% in 1986," says Steven Weinberger, director of international marketing, "and while we don't think we can keep that growth rate up, we'd sure like to see something in the 50% range this year."

Student demonstrations

Most major U.S. corporations appear to be committed to maintaining at least some kind of presence in China, the recent student demonstrations in several Chinese cities notwithstanding. Indeed, there may even be a positive side to the student demonstrations, suggests H. Charles Langford, president of China/Tech, a joint venture consultancy between Technology Clearinghouse of China, part of the Chinese Association for Science & Technology, and Atlanta-based Technology Exchange Corp. Langford, whose clients include Apple Computer Inc., says the very fact that Chinese newspapers have made note of the unrest and are willing to permit foreign journalists to photograph it indicates "increasing openness to the West."

Moreover, long-term prospects for trade in computers and communications, scientific instrumentation and durable machinery remain good, says David Laux, President Reagan's advisor on China at the National Security

Council. China, he says, looks at the "economic miracles" that have occurred in the other "four tigers" of Asia — Hong Kong, Taiwan, Singapore and South Korea — over the past 10 years. In three of those four high-tech hotspots, those "miracles" were performed by ethnic Chinese. With the proper infrastructure, Laux says, China believes it can duplicate those successes at home, and one day compete with its Asian neighbors in the global market.

But even though China has a long way to go before it wants to become Asia's fifth tiger in the Far East, there are signs that the cub is stirring in its lair. Right now, for example, reports Liu Dan, general manager of the Shanghai branch of the China National Import & Export Corp., there is a group of consumer electronics companies in Shanghai, called the Panda Group, which has set its sights on the world market. Panda, which makes low-priced radios, televisions and tape recorders primarily for internal consumption, wants to compete with Goldstar and the Samsung Group of South Korea, Liu says. The designs, he admits, are "a bit old-fashioned," but Liu believes it will only be a matter of time before Panda streamlines its product line and starts hunting for outlets in the West.

Meanwhile, China continues to experiment with some aspects of capitalism. And because high tech is absolutely vital to China's modernization effort, some of the first reforms have been aimed specifically at equity joint ventures involved in electronics. In addition to "technology transfer," China hopes these high-tech companies will also generate needed foreign exchange for China's depleted coffers.

The new economic reforms, which were officially promulgated last October, will start to take effect this spring, as the nation's vast network of provincial and municipal bureaucracies starts to translate the central government's reform edicts into action. Political reforms, to which recent student demonstrations have been a kind of prelude, are expected to be announced this October at the next Communist Party Congress.

Many veteran China watchers are skeptical that life will get any easier for U.S. corporations in the years ahead

Most analysts believe that as the reform movement strengthens, U.S. businesses will be in a better position to justify investing in China. Under the current labor management system, for example, most U.S. companies have to take whoever is assigned to them, and dismissals are difficult, if not impossible. The reforms could change all that. In addition, wage rates at joint ventures are expected to become more competitive with local wages.

At the same time, joint ventures have gotten approval to begin swapping currency among themselves. This will make it easier for U.S. firms to repatriate profits. High-tech firms also will become eligible for preferential tax treatment and land-use fees and given favored access to scarce resources like electricity and purified water.

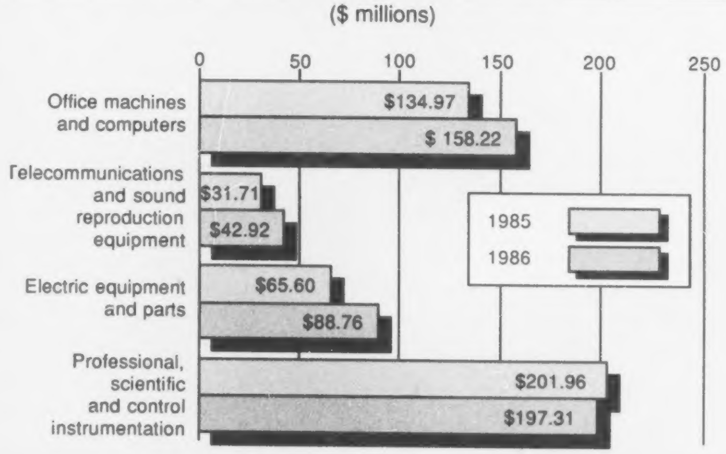
Also, as part of the new policy, China is expected to increasingly provide foreign exchange for the first time to manufacturing ventures which have been designated as "import-substitution companies," so called because they manufacture products that would otherwise have to be imported. These companies will receive foreign exchange for sales instead of local currency which cannot be converted on the world market. And if China has to borrow money from the West to achieve some of these objectives, it will, analysts say — be another departure from prior policy.

Part of the reform process too is aimed at promoting younger, college-trained, Western-oriented individuals into key positions in the bureaucracy. "In virtually every city, you now have around the mayor a number of vice mayors with specific responsibilities, including high-tech and other emerging industries," adds Sidney Rittenberg, the former head of ComputerLand China franchise and now president of the Los Angeles-based consulting firm, Index/China, a division of Index Systems Inc.

At the next Party Congress, others say, there may be even some discussion about putting factory managers in charge of the actual factories they are supposed to be managing. Under the current system, the Party secretary attached to each work unit has more authority in economic matters than the factory manager.

In all likelihood, future guidelines implementing economic reform will be published periodically throughout 1987, according to Gu Mu, head of China's cabinet-level State Council

The pace of U.S. electronics exports to China in the first nine months of 1986



Source: U.S. Commerce Department

Leading Group on Foreign Investment. The most difficult set of guidelines — dealing with currency conversion — will probably be the first to be published, state councillor Gu recently told a high-level delegation of U.S. electronics executives.

In addition to national reforms, many local municipalities have also tossed in a few reforms of their own. Shanghai's Yangtze delta region, for example, which accounts for one-third of China's total high-tech production, is instituting a whole series of local reforms to attract additional foreign capital and improve conditions for foreign joint ventures. The reforms are being welcomed by U.S. firms already in operation there, including Shanghai Foxboro Company Ltd. and Wang Computer Industry Development Company Ltd.

"We are aware of the complaints that our American friends have," says Liu Zhen-yuan, Shanghai's vice mayor for electronics and emerging high-tech industries, "and we're trying to do something about it." Liu is currently in the process of setting up a new computer science university in Shanghai to provide graduates for foreign joint ventures.

Many veteran China watchers, who have lived through other so-called "reform movements" in the past, are skeptical, however, that life will get

Wang Labs sets up a joint venture in Shanghai

After several abortive attempts, Shanghai-born An Wang, founder and chairman of Wang Laboratories Inc., last year finally set up a joint venture in China to manufacture desktop computers.

Wang, who fled his homeland in 1948 during the civil war that brought the Communists into power, has always been intrigued by the potential for high-tech manufacturing in China. But negotiations over three previously announced efforts to create joint ventures in China [ELECTRONIC BUSINESS, June 1, 1985 p42] never bore fruit. To Wang's dismay, all three projects reportedly stalled in a mire of bureaucracy and red tape.

Finally, though, the two sides worked out a deal. China, industry sources say, caved in on key demands after Wang threatened to abandon China and set up another manufacturing operation in Taiwan. So last October, Wang formally announced the formation of Wang Computer Industry Development Company Ltd., a Shanghai-based 60-40 joint venture between Wang Labs and Shanghai Computer Corp., with Wang holding the controlling interest. Total registered capital for the new company — which employs just under 50 people, including five department managers from Wang's Hong Kong operation — is $6 million.

To celebrate the opening of the plant, China last year even waived its bureaucratic airline regulations to allow Wang to fly into Shanghai from Tokyo on his private jet. The ceremony, too, took place on Oct. 11, the same day China announced its widespread economic reforms — a symbolism that was not lost either on Wang Labs or the Chinese.

Wang Labs says the new company will manufacture Chinese-language workstations built, for the time being at least, exclusively out of imported components. In the first full year of operation, the firm plans to turn out 1,000 units, all for internal Chinese consumption. Once local components pass Wang's rigid quality control standards, "we will consider exporting the product," says Raymond So, the general manager of the operation who divides his time between Shanghai and his home in Hong Kong.

Ted Fitzgerald

AN WANG: After three abortive attempts, he was finally able to set up a joint venture in Shanghai

General manager So also says Wang is working with the Chinese Ministry of Electronics Industry on a program to bring local component makers up to global standards. He says Wang's target is to start sourcing local connectors, integrated circuits, transistors, capacitors, printed circuit boards and other components by the fourth quarter of this year or by the first quarter of 1988.

Almost all of the Chinese employees at the Wang joint venture are college-trained engineers or technicians. They will form the nucleus of the management team that will run the new company's highly automated production lines. Once they know how to do the work themselves, So says, they will then be able to train the real production workers that Wang plans to hire at a later date. But it is important, the Wang general manager says, for the managers to be able to first master basic manufacturing skills. "If a supervisor just talks about how to do a job, but doesn't know how to do it himself, how will he be able to earn the respect of his staff?" asks So.

There have, of course, been some initial problems. So says Wang has already had to dismiss one employee who was unable to adjust to Western business practices. Local Shanghai government officials also say the joint venture had to wait about a year to get a license from the Pentagon to import a vital piece of U.S. test equipment for use in manufacturing.

Nevertheless, Wang appears to be pleased with the progress of the joint venture. Despite China's socialist system, Wang believes the Chinese are ready for American-style capitalism. "Underneath the surface, there is a lot of individualism in China," Wang says. "And compared with Japan and Korea, there is a lot more liberalism."

any easier for U.S. corporations in the years ahead. In a nation of one billion people, most of them peasants, life moves slowly, they say, despite the best intentions of a whole new strata of younger technocrats that Premier Deng Xiaoping, the chief architect of reform, has put into place.

China's passage of its first patent law several years ago is a case in point. In 1978, the law was first proposed, according to Doris Wan Cheng, a consultant with Chicago-based U.S.-China Investment & Trade Corp. But it took two years of discussion before the country was able to pull together a national conference on the subject.

Citing the importance of West-East technology transfer, technocrats argued for rapid passage of patent legislation. No Western company would enter China, they pointed out, if their proprietary technology was appropriated. However, others argued against the proposal on the grounds that patents would only benefit Western companies. Meanwhile, a third faction argued that patents were a good thing, but the country should not be in such a rush to implement them.

Finally, after a long ideological debate, the technocrats won. A patent law was drafted and passed in 1983. But it is only just now being implemented, Cheng says. And even with the law on the books, there are still plenty of complaints about alleged patent infringement, and in many cases, it is still unclear which court, if any, will be the arbiter of these disputes. In recent years, Data General Corp., for example, reportedly has made some important inroads into China, but it would probably sell more minicomputers there if it did not have to compete with locally produced machines based on pirated DG technology.

Speed of reform

But the Chinese, in fact, are moving quickly to rectify past mistakes, according to C.B. Sung, chairman of Unison Inc., a San Francisco-based financial services and consulting firm whose client list in China includes Sun Microsystems Inc. and Varo Inc. Sung, who also owns a one-quarter interest in the Great Wall Hotel in Beijing, says that within one month of the October reforms, his joint venture hotel — which generates huge quantities of foreign exchange — was swapping currency with American Motors Corp.'s Beijing-based joint venture which generates *reminbi* (local currency) through the domestic sale of Jeeps. The swiftness with which these currency transactions were sanctioned by the government was unprecedented, says Sung.

Nevertheless, while most U.S. corporations, which earn *reminbi* by selling products to the local market, are more than happy to exchange Chinese currency for dollars, there is a downside to this arrangement. In Shanghai, for example, the joint-venture to joint-venture exchange rate late last year was 4.7 *reminbi* to the dollar — versus 3.7 *reminbi* to the dollar, which was the official exchange rate.

C.B. SUNG, part-owner of the Great Wall Hotel and a consultant to Sun and Varo, predicts the reforms will be implemented quickly

While cash-heavy joint-venture hotels make out well in these deals because they are paying for their labor and supplies in local currency, foreign manufacturers still have to pay a penalty, sometimes as much as 25% to 35%. Gerald H. Gleason, vice president of Foxboro Co., which runs a profitable, 365-employee joint venture in Shanghai to manufacture industrial controls, says these government-sanctioned currency swaps may be a "good means of dealing with this problem for the time being in certain situations, but it's no way for joint ventures to survive."

A lot of what happens in China over the next few years, however, will depend on outside forces over which that country has no control. If petroleum prices rise, for example, China — a petroleum exporter — can more easily replenish its foreign reserves and purchase more electronics equipment. China, too, has had bountiful harvests in recent years, but a serious reversal in the agricultural sector could also throw a monkey wrench into modernization efforts.

Also, a lot depends on the degree to which the U.S. Department of Defense and Paris-based Coordinating Committee for Multilateral Export Controls (COCOM) relax their restrictions on high-tech exports to Communist nations. Currently, for example, there is a tremendous pent-up demand in China for U.S. semiconductor production equipment used in the manufacture of integrated circuits with linewidths of under three microns. If licensing procedures were liberalized, says He Mingzhang, a deputy manager in charge of component policy at the government-run China National Electronic Devices Corp., "we [in China] estimate we would buy over $200 million worth of IC equipment from the U.S."

But China cannot count on any of these things to happen. It can, however — through a variety of reforms — control events within its own borders. While reforms can prompt dislocations in the economy, including inflation and unemployment, China will continue to experiment with them, analysts say. Sullivan of the National Council for U.S.-China Trade says his greatest fear is *not* that the reform movement will reverse itself, but that it will be slowed by China's entrenched bureaucrats, many of whom may lose their political fiefdoms through reform.

In the meantime, most U.S. computer and electronics companies have adopted a "wait and see" approach. "Everyone here is aware of the enormous potential [for East-West trade]," says Raymond So, general manager of Wang Laboratories Inc.'s computer manufacturing joint venture in Shanghai. "But how soon the China market will really open up to the West is a matter of conjecture. It may take three years; it may take five; it may take 10. Nobody knows. But we are prepared to make a long-term commitment to China. And when China does open up, we'll be ready."

Some information in this report was obtained from speeches by individuals at recent seminars on China sponsored by the American Electronics Association; T.L.I International Corp. of Chicago; and the International Business Center of New England Inc. in Boston.

MRP II is alive, but will it ever thrive?

DEC, HP and IBM hope so. Their hardware sales stand to climb if MSA and others deliver the right manufacturing software

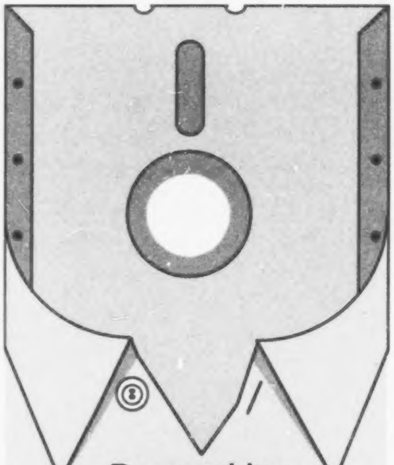
By Mary Jo Foley

Throughout the 1980s, automation has been touted as one of the best ways to restore competitiveness to U.S. manufacturers. Yet, demand by American businesses for manufacturing resource planning (MRP II) software, seen by many as the keystone to true computer-integrated manufacturing, has remained flat throughout most of the decade. The U.S. MRP II market was barely $400 million last year.

Some analysts say this discrepancy exists because complete MRP II systems — comprised of any number of modules including materials and planning control [also called MRP I], lot tracking, shop-floor control, just-in-time (JIT) production, purchasing, manufacturing accounting and so forth — are too expensive for companies outside the *Fortune* 500 realm to buy and maintain. For example, an average system, minus the hardware, can run as high as $200,000.

Others say existing MRP II software is too data-processing oriented to be helpful to the people it is designed to serve: managers and supervisors who require real-time manufacturing data at the shop-floor level. And other market researchers and MRP vendors claim rapid advances in MRP II technology have resulted in the market surpassing the needs of potential customers, many of whom still rely almost entirely on manual manufacturing-related processes.

As a result of these and other causes, MRP II is a market considered to be near death by numerous industry analysts. "MRP II will experience the same, slow death as U.S. manufacturing, unless the software community changes the basic nature of what they're selling," says one such analyst, Glen Almendinger, president of Boston's Harbor Research Corp.



Demand by businesses for MRP II software has remained flat for most of the decade

Within the past year, these ill-wishers nearly saw their predictions come true, as evidenced by the confused spate of year-end acquisitions, mergers, new product cancellations or delays, or both. In the biggest move of the year, Atlanta's Management Science America Inc. (MSA) bought out two MRP firms: RTS Ltd. of Dublin, Ireland, a maker of IBM-based mini packages; and Comserv Corp. of Eagan, Minn., one of the granddaddies of mainframe MRP II.

Remaining MRP vendors, meanwhile, axed long-anticipated debuts of software for mainframe computers and microcomputers. ASK Computer Systems Inc., for example, decided to halt work on adapting, or porting, its Manman package, originally developed for the HP 3000 machines, to the oversaturated and somewhat sluggish IBM 43XX system marketplace. Other vendors shelved new product plans, often citing user MRP overload as their reason. Micro MRP Inc., for instance, is holding off on promoting its just-in-time module.

Even the host of new minicomputer and mainframe models introduced by nearly all of the top computer vendors during 1985 and 1986 were not enough to boost sagging MRP morales and shipment levels. Hewlett-Packard Co. (HP), one of the few computer hardware manufacturers to develop and sell its own MRP II package, for one, openly questions the appeal of powerful uniprocessors to manufacturing companies interested primarily in distributed processing involving multiple midscale systems.

"It's still not clear how significant the impact will be," HP's Michael Galane says of his company's new high-end Spectrum minicomputers, "since few customers are running MRP on our existing top-of-the-line [computers]." Galane is research and development manager for HP's newly created Manufacturing Productivity Division in San Jose, Calif.

Relief may be in sight

But relief — although only temporary — may be in sight. Despite the fact that nearly all of the MRP leaders say they expect this year to be another flat one, several industry watchers have stuck out their necks by calling for substantial MRP II sales growth in 1987. "The market definitely will grow in terms of companies interested in doing MRP," says Christopher Grey, president of Oliver Wight Software Research, a market research firm in Newfields, N.H.

International Data Corp. (IDC) is far less conservative in its outlook. The Framingham, Massachusetts-based market research firm predicts mainframe and minicomputer MRP II software sales will jump a whopping 40.3% to $598.7 million this year.

"The doldrums of the last couple of years occurred in part because users were making long-term plans to buy systems," explains Adam Zais, IDC's director of computer-integrated manufacturing (CIM) services. This is the year users finally will take the plunge. Next year, however, Zais says, a more characteristic 20% MRP II growth rate will resume.

Much to the delight of most of the MRP industry, demand for the long-standing top two MRP products — Copics (IBM's mainframe MRP II software) and Mapics (its mini-MRP II package) — at last appears to be waning. The importance of the IBM name on products — that are little more than "financial/inventory systems," in the words of Zais — is shrinking in the face of meaningful enhancements being introduced by IBM's competition. These include benefits such as artificial intelligence-based user interfaces, compatibility with the Unix operating system and built-in links to standard computer-aided design and engineering (CAD/CAE) packages.

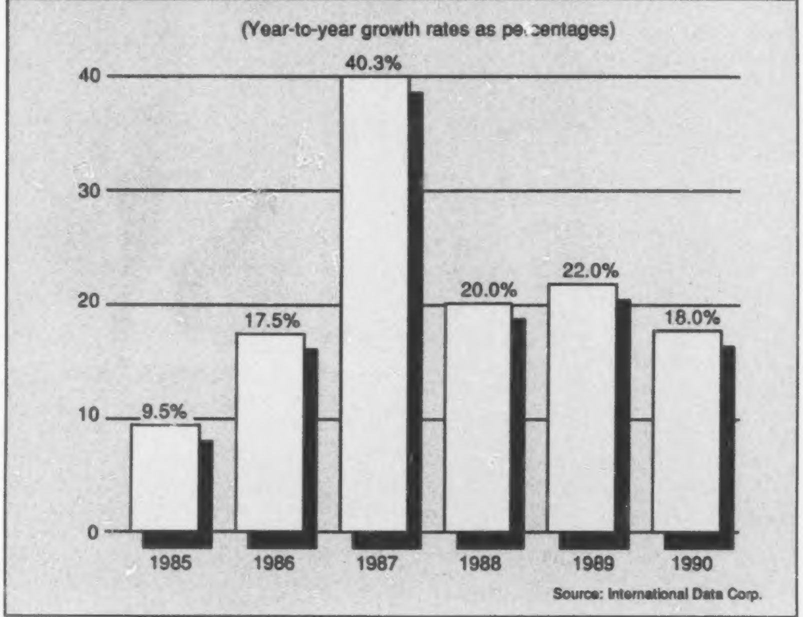
"If IBM wants to continue to dominate the [MRP II] market, it just needs to introduce an updated line," cautions Grey. But according to most sources, the Armonk, N.Y., giant does not have new MRP products waiting in the wings — at least for now.

Most other major computer manufacturers, with the notable exception of HP (which claims MRP II is its best-selling software product), are loathe to enter the hotly contested MRP world. Granted, NCR Corp., Unisys Corp. and Xerox Corp. continue to sell their own MRP II packages. But the vast majority are following in Digital Equipment Corp.'s successful footsteps by forging relationships with established third parties for their MRP II packages. In a major coup, DEC this past year signed three of the industry leaders — ASK, Cincom Systems Inc. and System Software Associates — as full-fledged DEC Systems Cooperative Partners. Under the arrangement, a partner either resells DEC hardware or refers customers to DEC for their hardware purchases; DEC, in turn, steers its hardware customers toward its software partners when such customers seek MRP II solutions.

In addition, a growing number of MRP software vendors claim to be looking into selling integrated MRP II turnkey systems (if they are not doing so already), thereby becoming major value-added resellers for computer manufacturers. MSA, for example, is evaluating the possibility of reselling IBM's new 9370 superminis with its MRP software, according to MSA executive vice president Dennis Vohs.

This reliance by computer manufacturers on independent software vendors does not mean the hardware vendors do not have a direct stake in MRP. Additionally, because most MRP II systems are sold in conjunction with new computer systems, it matters quite a bit which vendors' software has been ported to which

The lengthy MRP/CIM business cycle peaks: MRP II software sales in the U.S. skyrocket in 1987



Source: International Data Corp.

The ABCs of MRP

The term MRP II was coined by manufacturing guru Oliver Wight during the late 1960s, at the time when IBM and Pick Systems were pioneering the concept of factory-automation software. MRP II software — so designated to distinguish it from MRP I [materials requirements planning] packages, which are a subset of MRP II — may consist of any number of modules linked together. Typical modules include inventory control, bill of materials, master scheduling, MRP I, routing, purchasing, general ledger, capacity planning, shop-floor control and order entry, among others.

The easiest way to picture MRP II, suggests International Data Corp. analyst Adam Zais, is as the third "leg" of the computer-integrated manufacturing (CIM) "stool," with the other legs being computer-aided design/engineering (CAD/CAE) and computer-aided manufacturing (CAM). In the ideal factory of the future, the three systems should be able to exchange data via a common database. This way, for example, an engineer would be able to check whether parts were available using a system's MRP inventory control module before designing them into a project using a CAD system. ☐

vendors' machines.

In mainframes, where IBM totally dominates the marketplace, the porting issue is less crucial. But in minicomputers, it is vital. At the end of last year, 39.7% of all mini MRP II software was running on IBM System/3X equipment, according to IDC estimates. Another 24.6% was running on HP 3000 machines; 11.9% on DEC VAX systems; and the rest on various other minis.

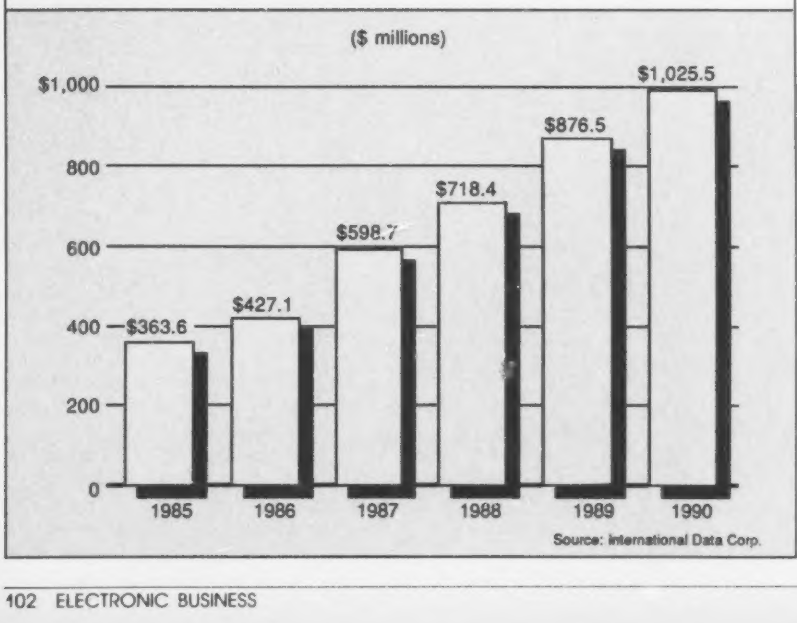
Those minicomputer percentages will change drastically within the coming years, predicts IDC's Zais, with DEC "quickly eclipsing HP" as the No. 2 MRP hardware vendor — mostly as a result of its strong third-party connections. At ASK, which sells both DEC- and HP-compatible versions of its MRP software, demand for the two versions has recently shifted from a 35% to 50% demand for DEC at HP's expense, says ASK director of marketing David Sohm. MSA's Vohs goes so far as to say "one of MSA's highest priorities will be to address the DEC marketplace." Currently, all of MSA's MRP II software is IBM-based.

IBM, meanwhile, "will maintain its installed base, but will have trouble maintaining a large share of the new (mini MRP II) shipments," Zais claims. In what amounts to more good news for DEC, mini-based MRP II will overshadow mainframe-based MRP II in terms of units and dollars in the not-too-distant future. "Already we're starting to see smaller systems," as opposed to single, centralized systems, "bought by customers as solutions to departmental and plant problems," Zais says.

MSA's VOHS: "One of MSA's highest priorities will be to address the DEC marketplace"

MRP II—hardly a dying market

Worldwide sales by U.S. vendors of mainframe- and mini-based MRP software



Source: International Data Corp.

On the micro front

This emphasis on distributed, departmental MRP solutions also makes for strong growth on the micro-MRP II front. Because there are between 75 and 100 companies that sell products ranging in price from $1,000 to $100,000 which consider themselves to be vendors of micro MRP software, it is difficult, if not impossible, to get a consensus regarding the size of the market. But, as noted by Richard Thau, president of the acknowledged market leader, Micro MRP, there are 400,000 manufacturing companies (potential customers) worldwide with revenue under $25 million. If 10% of them invest in micro MRP systems within the next five years, Thau says, the worldwide micro-MRP II market could reach anywhere between $3 billion and $5 billion.

Analysts agree micro MRP II is a market poised for growth. As evidence, several point to Micro MRP's customer list, which reads like a Who's Who in the electronics business: Harris Corp., IBM, Intel Corp., Eastman Kodak Co., Martin Marietta Corp., Westinghouse Electric Corp. and others. But to date, total micro-MRP II sales have approached nowhere near the 40,000 unit, $3 billion level. Thau's Foster City, Calif., company claims 1,400 installations to date. Few, if any of its competitors claim more than 300 installations.

In Micro MRP's case, neither high price nor lack of features is a sales deterrent. A typical multiuser IBM PC-based configuration of MAX (Micro MRP's production manager software package) runs about $10,000, and includes bill of materials, inventory control, communications interface, master scheduling, MRP I, purchasing control, shop-floor control, costing, management performance, interplant communications, accounting and data collection modules. Instead, Micro MRP may be too far ahead of its customers, Thau admits. The company recently completed successful testing of its new JIT module, but has been forced to shelve it temporarily due to lack of demand.

"A lot of repetitive manufacturing, upon which JIT is based, is still happening overseas more than here," Thau explains. "If you look at small- to mid-sized [U.S.-based] manufacturing companies, fewer than 3% are using computerized [manufacturing] systems. We've got to get our customers to walk before they trot."

Guarding against too-rapid technological advancement is not an issue limited to the micro-MRP arena. "The focus [of MRP II] today is on compatibility with office products, rather than adding new functionality and modules," says HP's Galane. Accordingly, simplifying and customizing HP's system, known as HP Manufacturing Management II, is the order of the day. "Customers want more flexibility," Galane explains. "They want ports germane to their businesses that don't affect [MRP II] source code. And they want better overall integration, providing timeliness of information to various departments."

HP has undertaken various technological and organizational changes to achieve these ends. The Palo Alto, Calif., company added screens to its system, allowing users to customize their MRP II systems without having to do any programming. HP also is expected to PC-level communications software that will enable users to integrate information generated and stored by existing PC software products with information within HP's MRP system.

On the organizational front, HP recently moved responsibility for its Manufacturing Productivity Division from its more technically oriented Manufacturing Systems Group to its commercially-oriented Business Systems Group. And, recognizing its product "isn't an entry-level, first-time user system," the company is ramping up its value-added channels program by providing customer referrals for more basic MRP II offerings, as well as MRP II software targeted at specific vertical niches, Galane says.

Large-scale MRP plans

MSA, like HP, is in the midst of structural changes designed to streamline its MRP business. At the beginning of the year, it established the MSA Advanced Manufacturing subsidiary, headed by executive vice president Vohs. It is responsible for MSA's, RTS's and Comserv's manufacturing products. The three lines last year generated $100 million in MRP sales, Vohs says. Some analysts claim that MSA, as a result of its acquisitions, already is the new No. 1 MRP II vendor.

> "The focus [of MRP II] today is on compatibility with office products, rather than on adding new functionality and modules"
>
> Michael Galene of Hewlett-Packard

Most of MSA's efforts in the coming year will center around making its three product lines compatible. The company also will work to enable its Information Expert product, which is a natural language/expert system designed to facilitate user access to MSA's various application software, to interface with Comserv's MRP products. Finally, Vohs says, MSA will work with vendors of industry-standard CAD/CAM, bar coding and other manufacturing-related software, to develop built-in links between their packages and MSA MRP products. Comserv's AMAPS package already contains a module which enables it to interface directly with IBM's CADAM package.

ASK Computer earlier this year introduced its own version of a CAD/MRP link, called Manman Engineering. Additionally, several ASK customers have built their own links between Manman and various automated storage and retrieval systems. In the coming year, the Los Altos, Calif., company plans to focus on marketing turnkey systems costing under $80,000 based on DEC's MicroVAX and HP's Micro 3000, according to ASK director of marketing Sohm. And, like other MRP II vendors, ASK "will try to understand the requirements of specific vertical markets," Sohm says. "We'll focus on vertical niches [such as automotive, electronics and defense], which have the opportunity to expand to other markets in the future." ☐

IBM hangs onto its installed-base lead in mainframe-based MRP II software...

Company	Number of system sites	Percentage of total MRP sites[1]
IBM (Copics)	500	3.4%
Comserv [2]	480	3.0%
Sperry [3]	400	3.0%
Cullinet	250	1.5%
Management Science America	211	1.5%
Martin Marietta	200	2.8%
Burroughs [3]	185	1.0%
Honeywell	175	1.0%
Cincom	150	1.0%
Xerox	150	1.0%

...as well as in mini-based MRP II

Company	Number of system sites	Percentage of total MRP sites[1]
IBM (Mapics)	3,500	24.0%
Hewlett-Packard	1,500	10.0%
NCR	1,188	7.0%
ASK	1,000	7.0%
Pilot	1,000	6.0%
System Software Associates	688	4.0%
NCA	600	4.0%
Data 3	325	2.0%
Management Science America	300	2.0%
Martin Marietta	200	2.0%

[1] Total number of mainframe, minicomputer and microcomputer-based MRP system sites = 14,700

[2] Management Science America bought Comserv in 1986

[3] Sperry and Burroughs merged in 1986 to form Unisys

Source: International Data Corp.

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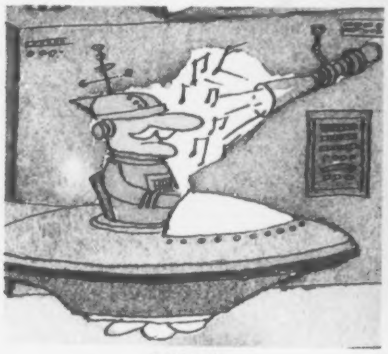

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Cover photo/Tim Davis

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BPA ABP

Modest growth projected in 1987 for electronic components

Our in-house forecasting unit anticipates a definite improvement. Other researchers agree

Look for moderate growth this year in industrial production of electronic components (SIC 367), including semiconductors. As business picks up slowly in most electronic end-equipment markets, component manufacturers will be assured of continued recovery this year. By year-end, according to Cahners Economics, component production in the United States will have reached the same level of activity as the second quarter of 1984.

Semiconductor production accounts for the largest part of SIC 367. As early as January, Andrew A. Procassini, president of the Semiconductor Industry Association, was saying that the "apparent improvement in business conditions during December" boded well for the new year. At that time, Procassini also noted that U.S. semiconductor shipments for 1986 had reached an estimated $8.5 billion, up 5% from $8.1 billion in 1985, but 27% below 1984's record $11.6 billion. Although the SIA's figures measure consumption, rather than production, they spell out a better environment for U.S. chip makers.

Other independent market researchers tend to support this projection. Most conservative is In-Stat Inc. The Scottsdale, Ariz., semiconductor market specialist figures that growth will be sluggish. In late January, it was forecasting 5.1% growth to $8.86 billion in North American semiconductor sales for 1987. Worldwide, In-Stat said, sales would increase 9.3% to $28.93 billion.

Dataquest was more bullish. Last time we looked, the firm was projecting an 18% increase in worldwide consumption of semiconductors this year and 12% increase in the United States — with most of the growth occurring in the second half of the year. Over the 1986-1991 period, Dataquest says U.S. semiconductor consumption is likely to climb at a 12% compound annual growth rate. The firm attributes the anticipated rise in orders to increased growth in Southeast Asian markets, including South Korea and the People's Republic of China; the trend toward establishing local manufacturing facilities around the world; and the emerging need for orchestrated research and development programs involving industry, such as the Semiconductor Research Corp. and the proposed Sematech program.

Moderate growth is also forecast for components other than semiconductors. The market for switches, for example, which has historically accounted for 1.3% of all electronic component shipments, is expected to reach $773 million in sales at the producer level by 1990, according to Marketdata Enterprises, an industrial research firm in Williston Park, N.Y. That represents a 5.5% annual growth rate (including inflation) from an estimated $601 million in sales last year.

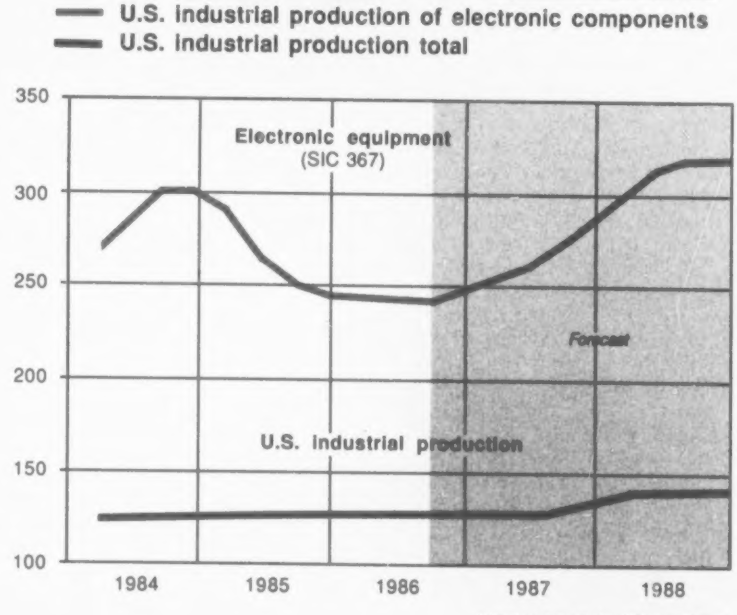
In monitors, which also fall under SIC code 367 for electronic components and accessories, look for an average annual increase of 14.8% in nonconsumer applications to $8.66 billion through 1993, according to International Planning Information Inc. in Redwood City, Calif. Unit volume, at the same time, will grow only 10.2% annually to 42.3 million units in 1993.

Innovations in surface mount technology are also expected to generate some additional demand. The New York City market research firm of Frost & Sullivan Inc., for example, sees a major expansion in surface-mounted devices (SMDs) in Europe — from $657 million in sales last year to $1.9 billion in 1991. During that time frame, SMDs, which today account for less than a tenth of all electronic components in Europe, will climb to nearly a fifth.

AL FURST

Electronic components

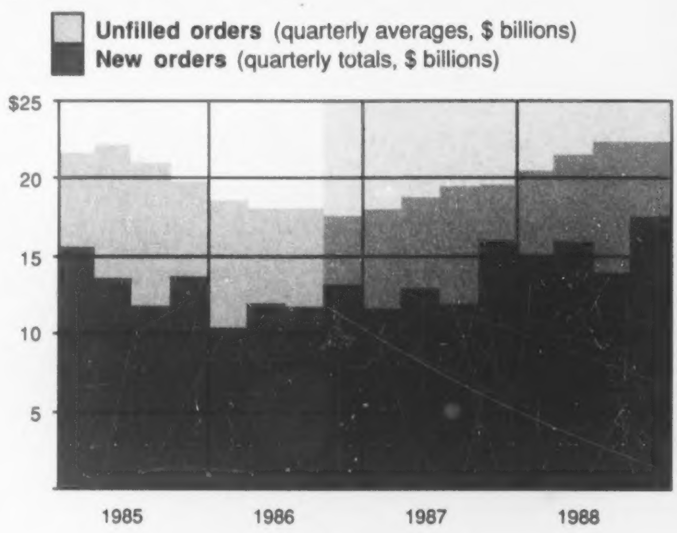
Industrial production indexes, 1977 = 100



Historical data: Federal Reserve Board
Forecast: Cahners Economics

Office and computing equipment

(SIC 357)



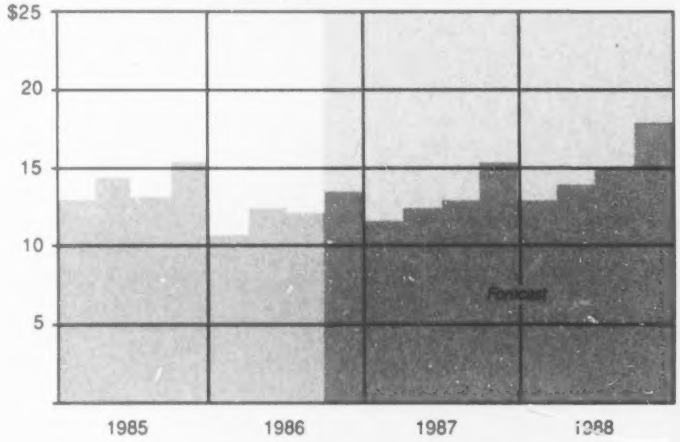
New orders

Manufacturers received $11.6 billion in new orders during the third quarter of 1986, down 1.7% from the prior quarter. This was a strong performance for the summer quarter, when business is traditionally sluggish. In fact, after seasonal adjustment, orders would have increased 16.5%, their sharpest improvement since early 1985. Despite the industry's second-half gains, weak order rates earlier in 1986 are responsible for an expected loss of 13.9% to $46.6 billion for the year. But rising export sales, a large number of new product introductions and an anticipated turnaround in investment by U.S. businesses should bring a return to growth this year. Orders are expected to rebound 11.5% in 1987 and nearly 20% in 1988.

Shipments

Although orders began to show signs of improvement last summer, shipments continued to struggle along just as they had earlier in the year. In the third quarter, producers of computers and office machines shipped $12.0 billion worth of equipment, down slightly from $12.3 billion in the second quarter. Annually, shipments are expected to reach $48.1 billion, 13.3% below 1985's level. Conditions currently look favorable for a return to moderate growth in the computer industry. If orders sustain their present uptrend, then shipments will improve gradually during most of the current year, achieving an overall annual growth rate of 7.7%. Shipments are expected to increase 15% in 1988.

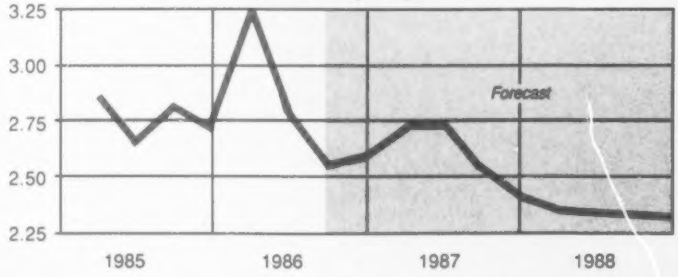
Office and computing equipment: Shipments
(quarterly totals, $ billions)



Unfilled orders

After declining almost without interruption for more than two years, manufacturers' order backlogs began to stabilize in late 1986. They averaged $18.0 billion in the third quarter, down only slightly from the previous quarter's $18.1 billion. Early reports for the fourth quarter indicate that backlogs will post another modest decrease, but are expected to reverse direction in early 1987, expanding gradually as the year unfolds. Backlogs are expected to post an overall gain of 4.9% this year (up from a 14.7% loss in 1986) and then swell 14.2% more in 1988.

Office and computing equipment: Inventory-to-shipment ratio
(seasonally adjusted)



Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

Inventory-to-shipment ratio

The ratio of computer manufacturers' inventories to shipments fell to 2.55 in the third quarter from an average of 2.77 in the previous quarter. This drop brought the ratio about back to its level at the end of 1984, before the industry entered into a steep downslide. This implies that inventories have finally returned to the desired balance with shipments and that the recent process of inventory liquidation is now virtually complete. Look for manufacturers to maintain tight inventory strategies over the next several quarters, holding the I/S ratio within a normal expansionary range of 2.55 to 2.75.

New orders

Communication equipment manufacturers received $16.6 billion in new orders during the third quarter, up from a total of $15.9 billion in the previous quarter. Improvements were reported within both the defense and nondefense segments of the industry. This rise in activity extended into the fourth quarter, but was not large enough to prevent 1986 from showing a shortfall of 1.2%. Prospects for growth in 1987 and 1988 are somewhat brighter. Recent cutbacks in military procurement authority will restrain the defense-equipment market, but a pickup in capital spending by U.S. businesses is expected to revitalize the larger nondefense segment. This will push industry-wide orders up 4.9% to $72.0 billion this year and 11.0% more in 1988.

Shipments

Although orders for communication equipment were extremely disappointing in early 1986, high backlogs (especially for defense-related systems) enabled manufacturers to maintain a fairly steady rate of shipments. In the third quarter, manufacturers shipped $16.2 billion worth of equipment, a level which was equal to the prior quarter and up 7.3% from the third quarter of 1985. When year-end figures become available, 1986 should show an overall gain of 5.3% to $65.8 billion. Look for the growth rate to improve only slightly to 6.2% in 1987, before accelerating to 9.3% in 1988.

Unfilled orders

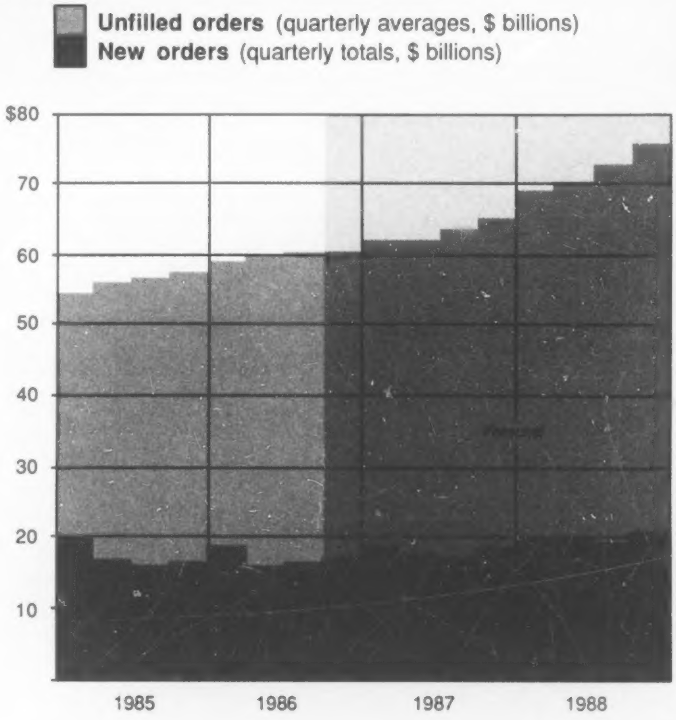
The communication equipment industry's backlogs increased 0.7% to $60.6 billion in the third quarter. But even though backlogs continued to expand, their growth rate was much less rapid than it had been previously. In fact, for 1986 as a whole, we expect to see an increase of just 6.8%, down sharply from the 19.4% gain recorded in 1985. Projections for modest growth in both orders and shipments this year, mean that backlogs are likely to show another single-digit gain, probably about 5.5%. The growth rate is expected to jump to 14% in 1988, as business conditions improve.

Inventory-to-shipment ratio

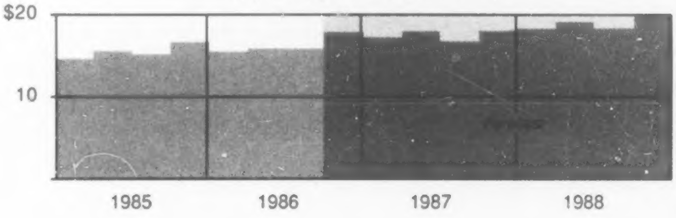
The ratio of manufacturers' inventories to shipments averaged 2.72 in the third quarter, down sharply from a reading of 2.87 in the previous quarter. This decrease reflects a continuation of tight inventory controls on the part of manufacturers. Inventories increased only 2% in the third quarter, while shipments surged ahead more than 8% on a seasonally-adjusted basis during the same period. The ratio is expected to edge slightly lower in the fourth quarter, as inventory depletion continues, before stabilizing in a 2.55 to 2.65 range in early- to mid-1987.

Communication equipment

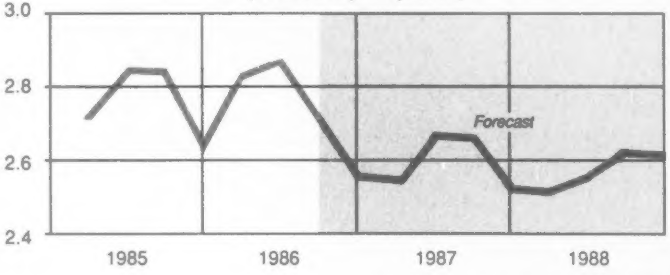
(SIC 366)



Communication equipment: Shipments
(quarterly totals, $ billions)



Communication equipment: Inventory-to-shipment ratio
(seasonally adjusted)



Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

It may be NCR, not IBM, in the store of the future

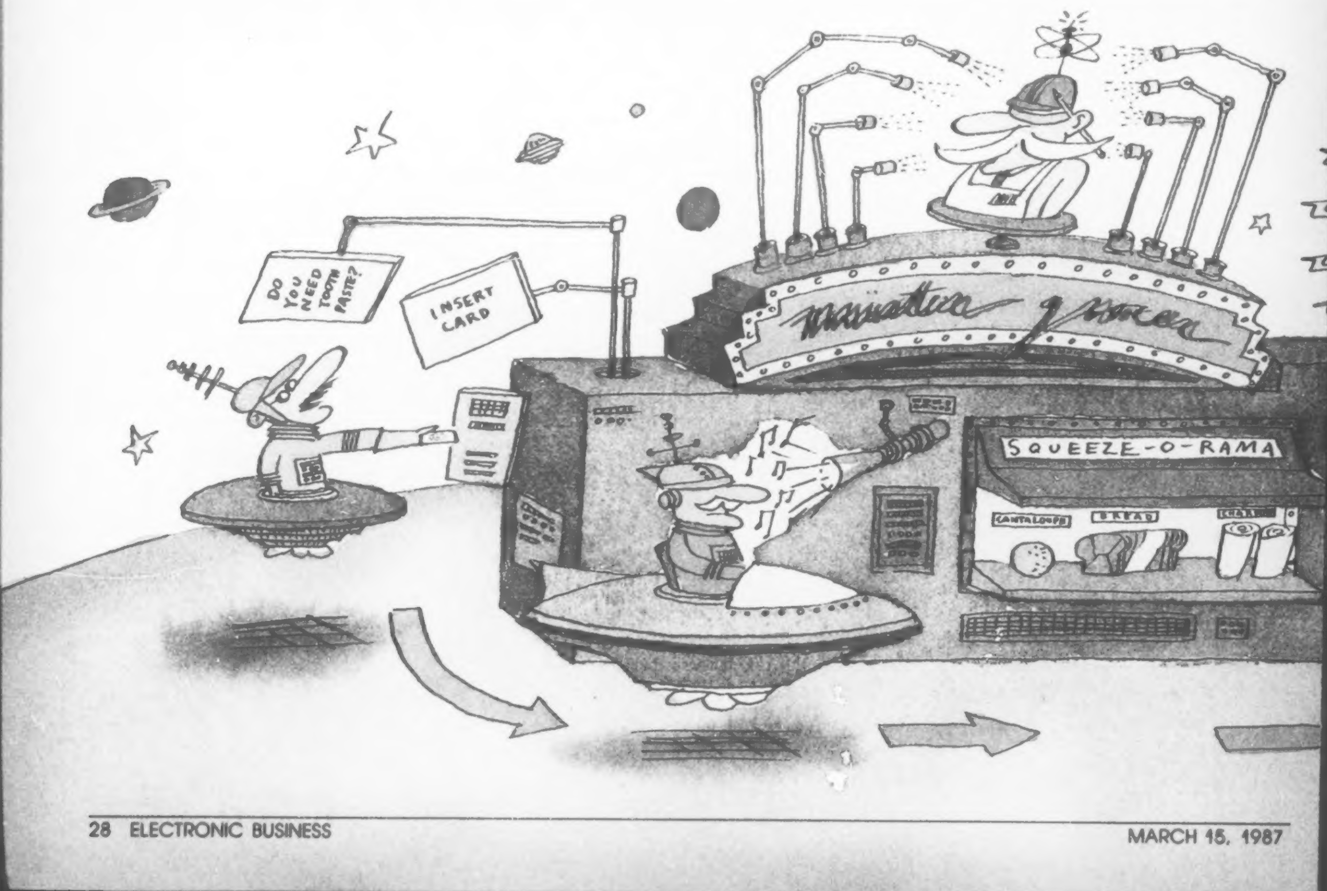
With nearly half the market, NCR are the initials with clout in the point-of-sale terminals industry

Old axioms don't always hold true. IBM does not always wait for a market to hit a billion dollars before it jumps into it. And the industry giant does not always win the lion's share of those markets it targets. IBM competes in the retail point-of-sale (POS) terminals market, estimated to reach $500 million this year, according to International Data Corp. (IDC), a market research firm in Framingham, Mass. And despite its efforts, Big Blue has been unable to chip away at NCR Corp.'s commanding lead in that market.

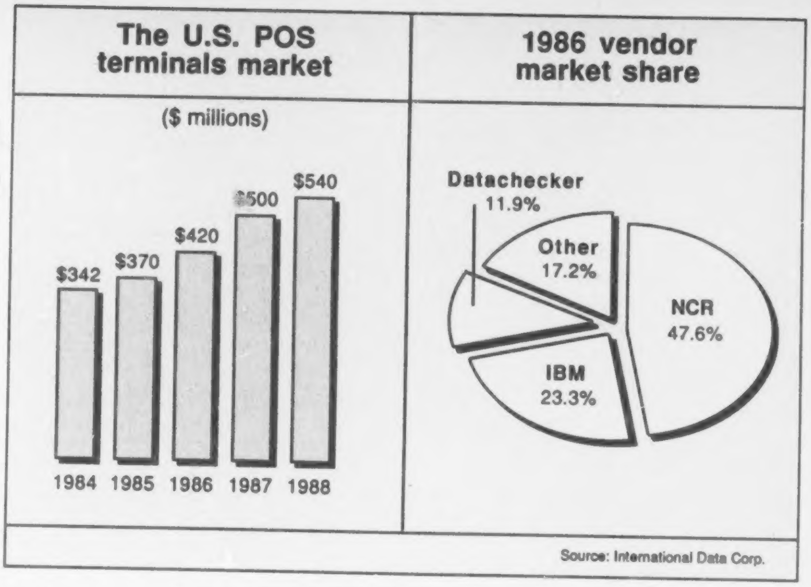
The retail store of the future — which might include 20 lane grocery stores with intelligent, electronic cash registers that do everything from keeping track of how many bananas are on the shelves to querying the consumers' bank account — may look slightly different than today's neighborhood fruit stand or local bookstore. But, more than likely, the equipment running those hypermarkets will bear the same three initials that they do today.

IBM does not mean all things to all people. In the POS terminals market, the Armonk, N.Y., company runs a distant second to NCR. According to IDC, IBM has cornered approximately 23% of the market while NCR has maintained the 47% share it has held historically. IBM's dominance in mainframes, which run the corporations that run retail stores, has had little effect on the company's ranking in the POS terminals market. In the retail industry, especially at the store level, says Steven Milunovich, an analyst with First Boston Corp., in New York City, customers trust NCR. "And it's harder to take share away at the terminal, or store, level than at the minicomputer, or departmental, level," says Milunovich.

NCR is well aware of IBM's lofty position in many retail stores' corporate headquarters. "We grudgingly have to admit IBM owns the lion's share of the back office," says Carl J. Steinmetz, vice president of NCR's retail systems division. To counteract any advantage that might give IBM, says Steinmetz, NCR has taken the same open systems approach, includ-



Hal Mayforth



Source: International Data Corp.

ing compatibility with IBM's proprietary Systems Network Architecture (SNA), in the retail market as it has in other arenas.

In January, NCR unveiled its next generation of POS terminals and high-end systems. The 7010, 7011 and 7032 systems, based on Motorola Inc.'s 68000 series of processors, can be configured with two processors which act as backup to one another in case either processor should fail. The result is a fault-tolerant system or what NCR calls continuous processors. In addition, NCR announced four interactive terminals and an IBM PC AT-compatible programmable terminal.

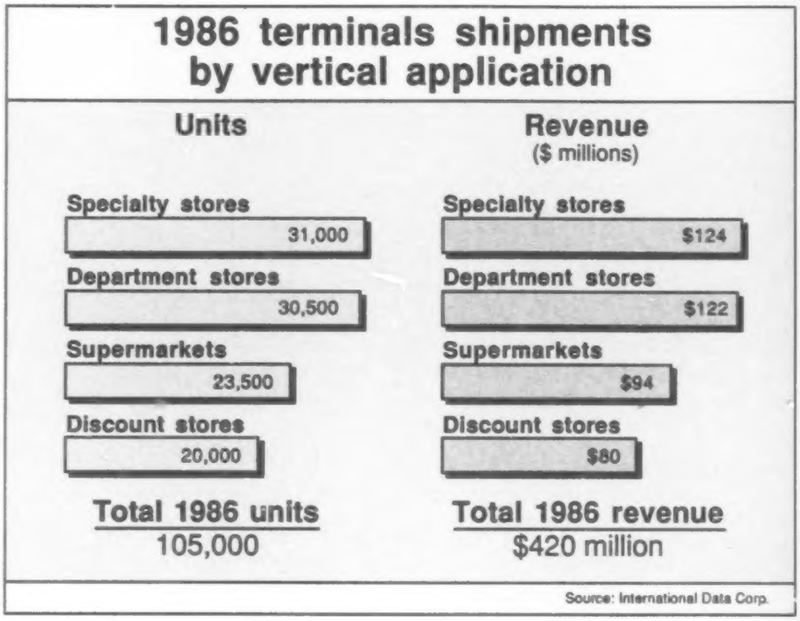
Positioned to automate

NCR also brought out over 50 software programming tools and a set of application packages specific to users in mass merchandising, department stores and food stores. NCR's new high-end machines can run NCR's real-time Continuous Processing operating system (CP/OS) concurrently with Unix, the standard operating system developed by AT&T. That enables NCR customers to run any number of industry standard software applications, in addition to retail-oriented packages, says NCR's Steinmetz. "If they don't like our office automation package," says Steinmetz, "they can use someone else's." Because of NCR's open systems approach, says Steinmetz, "we stand positioned to automate the entire store."

In light of NCR's recent announcement, First Boston's Milunovich believes NCR has cemented its lead in the POS terminals market. "NCR is clearly the leader," says Milunovich. The company's new offerings, adds Milunovich, have "advanced functionality at the same price as IBM." Dataquest's Brown agrees. NCR's new generation of systems, says Brown, "created new price points." A retail store, says Brown, "can now get everything it needs [to automate] from NCR for under $25,000."

Providing the best solution to the customer is particularly important in

PLEASE STAND BY FOR PICKUP
HAVE A NICE DAY
HM



Source: International Data Corp.

the retail market. The larger segments of the POS market — such as department and food stores — are saturated, says Peter A. Cohen, an analyst with IDC. "It is basically a replacement market," says Cohen. And while NCR has maintained its lead in the market, in part because of users' loyalty, retail customers replace POS equipment only every 12 years, says NCR's Steinmetz. If a customer is ready for the next generation of systems, and the vendor is not, it will be at least a decade before the vendor has a chance to sell to them again.

Smaller segments of the market, what IDC's Cohen calls "Mom and Pop" stores, are far from saturated, however. But many smaller, specialty stores use stand-alone electronic cash registers, made by Japanese manufacturers such as Casio Computer Company Ltd. and Sharp Corp. Total sales of stand-alone systems, says Cohen, are expected to grow 35% this year, to $688 million from $509 million. Sales of POS terminals like the machines made by IBM and NCR, however, have been recording a steady but modest 12% growth rate over the past five years.

In January, IBM announced enhancements to its System/36 operating system, SSP, which enables it to communicate with the company's POS terminals. Analysts agree, though, that NCR has little to worry about, even from the likes of IBM. If IBM's success in the POS terminals market has come at anyone's expense, it has cost Datachecker Systems Inc., the Santa Clara, Calif., subsidiary of National Semiconductor Corp. In January, Datachecker announced the company was closing its plant in Maynard, Mass., and laying off 250 manufacturing employees there. Larry Allman, Datachecker's executive vice president and general manager, says the company's sales have been flat for the past 18 months and he doesn't expect any improvement until the second half of this year.

But the company is making some changes this year that could bode well in the POS terminals market. Datachecker, like NCR, is concentrating more on software products than it has in the past. Over the past two years, says Allman, the company has been focusing on software research and development. Now, about 70% of its engineering staff are software writers. Last year, Datachecker was the first vendor to offer a 32-bit, AT-compatible system for stores. Datachecker has also offered fault-tolerance for the last three years on its proprietary minicomputer which acts as an in-store processor. "Our architecture is ahead of its time," says Allman.

ANNE KNOWLES

Eliminating "float" electronically

Today, it is difficult to remember life without automatic teller machines (ATMs). Initially, though, ATMs received a lukewarm reception from the consumer and acceptance was slow in coming. But once they took off, ATMs became ubiquitous.

The same thing may be happening with the concept of electronic fund transfers (EFTs), says NCR Corp.'s Carl J. Steinmetz, vice president of the company's retail systems division. In the case of EFTs, consumers can make purchases at retail stores that offer the service by using the same debit card used with ATMs. The price of the purchase is then automatically debited from the consumers bank account. While certain large companies, such as Mobil, have begun to offer the service and it has found popularity in certain regions, such as Florida, widespread acceptance of EFTs has yet to take place.

Consumer acceptance has been limited by the fact that EFTs are automatic. When a consumer writes a check, for example, the delay that occurs — between the day it is written and the day it is actually cashed — allows consumers to "float" funds. That float means the consumer can make a purchase whether money is in the bank account or not. Or the buyer can make interest on the money used to make a purchase during the delay between the day the check was written and the day the check is cashed.

But the problem with EFTs goes beyond consumer psychology. No one is sure who should pay for the service, says International Data Corp. analyst Peter A. Cohen. Retail stores benefit because of the high cost of bad checks. The banks benefit because EFTs are more automated than the check cashing process. And the consumer supposedly benefits by the convenience. But no one wants to pay for the service. "The banks think retailers should pay for it," says NCR's Steinmetz. "The retailers think the banks should pay for it. Ultimately," he adds, "the consumer will pay for it." □

The challenge to Microsoft in 386 operating systems

New players are emerging in operating systems due to the delay in fully optimized software for Intel's 80386

The whole personal computer industry may be talking about the new computers based on Intel's 32-bit 80386 chip, but to date no software exists to take full advantage of the chip's considerable power.

Despite the new computer chip's ability to handle several programs running at the same time and use massive amounts of memory for fancy graphics and number crunching, it is crippled by the lack of an adequate program — operating system software — to carry out those tasks fully. Redmond, Washington-based Microsoft Corp., which developed the operating system that has become a standard on IBM PC compatibles, has yet to release a version that can make the 80386-based personal computers reach their potential. Microsoft's competitors are taking advantage of this situation by trying to nip away at its dominant position as supplier of the systems.

One of the more frustrating problems for software applications developers is that current versions of the IBM PC's disk operating system (DOS) can only utilize 640 kilobytes of memory for applications. Software running on a computer with an 80386 chip, therefore, can only take advantage of a fraction of the 4 gigabytes that can be accessed by the microprocessor.

Operating-system software is the housekeeper of the computer. One of its main functions is to control a computer's abilities to store and retrieve information on disk drives and memory banks. It also manages certain routines inside the computer chip.

Current 80386 computers, such as COMPAQ Computer Corp.'s DeskPro 386, must use a Microsoft Corp. operating system designed for the 80386's relatively primitive predecessors, the Intel 8088 and 80286. That limits them to existing software applications that do not benefit from the 80386 except for an increase in execution speed.

Houston-based COMPAQ, IBM's closest rival in PCs, leapfrogged the computer giant's own standard when it announced and shipped the first 80386-based computer. Several other companies followed close behind COMPAQ. IBM, as of mid-January, had not announced its version based on the advanced chip.

Just as hardware companies have rushed their own 80386 computers into the vacuum left by IBM, software houses are taking advantage of Microsoft's lag by announcing their own operating systems or control programs that provide extra functionality on the 80386 computers.

The Software Link Inc., a small Atlanta-based software company, for example, hopes to gain acceptance for its own version of the 80386 operating system before Microsoft gets a 80386 version of DOS to the market. Software Link took the features of PC-DOS and upgraded them to take advantage of the new chip's capabilities. The company says that its PC-Modular Operating System/386 software can run several programs at once, support up to 25 other terminals linked to the host PC and allows applications to use large chunks of memory. The Software Link has been showing the program to developers since last October and it sent out copies of its operating-system program to 50 major software developers for technical review. The program will be available this winter.

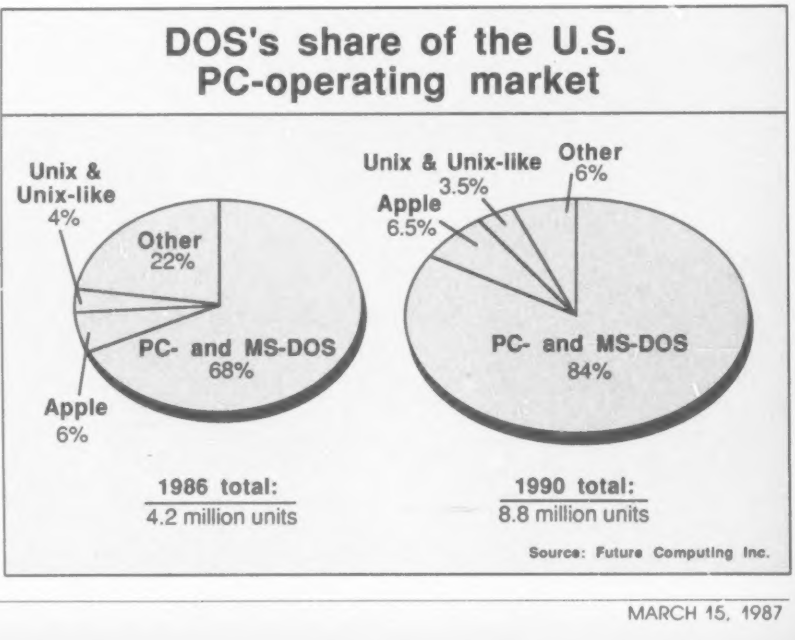
Other multitasking systems are also available that manage the 80386 in a way which simulates a number of standard IBM-compatibles within one computer. These so-called control programs permit the simultaneous running of more than one software application at a time. Several companies, such as Softguard Systems Inc., of Santa Clara, Calif., have already introduced such control programs.

Other operating systems, such as Pick and Unix are also likely to get a share, albeit small, of the 80386 market, says Meg Lewis, vice president of Dallas-based Future Computing Inc. "Some software that runs on DEC and other minicomputers will no doubt be written for the 80386 in Unix," she predicts.

But Lewis and others say it is likely that software applications developers will wait to see what Microsoft does before committing to an alternative system. Microsoft, however, has not announced when it will have an 80386 operating system, although consultants and analysts foresee it happening sometime in late 1987.

"There will be subsequent versions of DOS," concedes Adrian King, Microsoft's director of marketing for PC software. He would not be more specific except to say that it will support multitasking and use the power of the Intel 80286 and 80386 chips.

Meanwhile, COMPAQ claims that


DOS's share of the U.S. PC-operating market

Source: Future Computing Inc.

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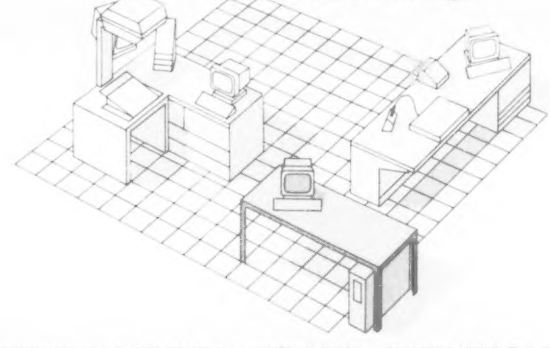

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the lack of a new operating system has not slowed down the DeskPro 386. The company claims that it sold more than 10,000 of the computers in the first three months since its introduction in September.

But consultants warn that sales could slow down soon. "Any new computer goes good out of the gate because power users buy it," says Alan Kucheck, a consultant for Novon Research Group of Berkeley, Calif. He added that new applications, which justify the expense and power of the 80386, will be needed to sustain that rate of sales.

Cautionary note

Andrew Seybold, president of the Seybold Group, a Torrance, Calif., consulting firm, is telling his clients not to buy 80386 computers right now because the next version of DOS has not arrived. He says that dealers are already discounting the DeskPro 386. "Given this state of affairs, we can't help thinking that it makes sense to be cautious," Seybold cautions. "Hold off on purchasing still another new-generation machine."

The Software Link, by virtue of being the first to the market with an 80386 operating system, says that it has a shot at wrenching control of the PC operating-software market from Microsoft. As Software Link's Gary Roberts, the company's director for sales and marketing, points out: "The best part is that we do have a product and Microsoft doesn't. We believe that right now we are in a very good position to get a foothold."

But overtaking Microsoft will not be easy. Microsoft, in partnership with IBM, developed the standard disk-operating system, PC-DOS, for the IBM personal computer. Microsoft also sells another version, MS-DOS, for IBM PC-compatible computers. To date, there is an estimated installed base of eight million PC-DOS and MS-DOS computers.

Moreover, Microsoft's King claims that Software Link's product really does not offer a new platform to build the next generation of applications on. "There is a whole infrastructure around DOS," he says. "An immense amount of software support is already out there in the form of debuggers, compilers, networking software and other tools." Microsoft, King says, will approach the next operating system from a different angle than the one Software Link is taking.

But what ultimately ends up being the standard for personal computers

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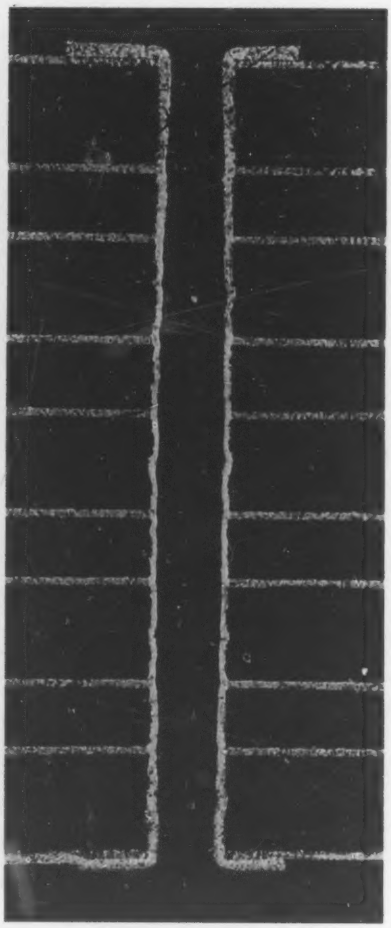

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will probably depend on IBM's move into the 80386 arena. Big Blue could develop a system that contains proprietary DOS functions, some analysts project. This would make the computer more functional within IBM's networks and also make it more difficult for other companies to copy.

"I'm convinced IBM is going to add its own enhancements to the 80386 chip," says Samuel Navarro, an analyst for Ladenburg, Thalmann & Company Inc., who is predicting a split in the IBM-compatible marketplace. "Either customers interested in staying within the IBM architecture of computer systems will buy an IBM, or those not interested will buy another machine."

ROBERT SNOWDEN JONES

Modem chips: The market starts to get crowded

Rockwell still dominates the modem microchip market, but here comes Fairchild, Intel and Silicon Systems

Despite recent reports, the modem market is not dead. Thanks to advancements in semiconductor technology, the number of modem applications is expanding and the major beneficiaries include both the traditional "modem in a box" manufacturers and the manufacturers of application-specific modem chips.

The increasing use of large and very large scale integrated (VLSI) chips and digital signal processors (DSPs) is causing modem chips to be made smaller, faster and cheaper. This trend, in turn, is bringing modem applications into areas such as pay telephones, credit card terminals and vending machines, to name a few. All of this is contributing to a U.S. modem market that is expected to grow from its current $978 million to about $2.4 billion by 1990, according to Timothy Bajarin, executive vice president at the research firm Creative Strategies International in San Jose, Calif.

But modems as we know them — black boxes that sit at the end of a telephone line to translate analog signals into digital signals and vice versa — are falling out of style. The future appears to be in integral modems: modems on a card, or on a single chip

Modem chips — a robust niche for semi manufacturers

U.S. consumption of ICs in modem equipment

	1985		1990	
Device type	Value ($ millions)	Market share	Value ($ millions)	Market share
MPU	$44.6	48%	$73.0	51%
Linear	20.5	22%	33.0	23%
Memory	15.8	17%	18.6	13%
Logic	12.0	13%	18.6	13%
Total	$92.9	100%	$143.2	100%
Implementation approach				
Standard	62.2	67%	71.6	50%
Semicustom	19.5	21%	43.0	30%
Custom	11.2	12%	28.6	20%
Total	$92.9	100%	$143.2	100%

Source: Gnostic Concepts

that can be plugged into a larger system such as a personal computer (PC). Indeed, modem chips built on a board or card represent less than 10% of today's market, says Bajarin. By 1991, however, he expects that number will jump to 70%.

As a result, a number of chip manufacturers that have an interest in the communications chip arena are hoping to expand their communications offerings by jumping into the modem chip arena — where U.S. consumption of integrated circuits (ICs) in communications products is forecast to grow from $3.45 billion at the end of 1987 to $6 billion by the end of 1990, according to Gnostic Concepts Inc., San Mateo, Calif.

Intel's foray

For Intel Corp., one of the newest hawkers of modem chips, the decision to offer a two-chip set of dedicated VLSI modem chips was a logical extension of the company's "commitment to microcommunications," says Mohan Passi, marketing manager for modems at Intel's Phoenix facility. Some industry analysts question Intel's venture into modem chips. The semiconductor manufacturer has already heavily invested in developing components for the eventual coming of a worldwide integrated digital services network (ISDN), which will eventually do away with the need for modems. Yet Edward Pullen, author of a Gnostic report on communication ICs, suggests that Intel's new venture makes a great deal of sense. Pullen expects modems will evolve into a communication interface unit within the ISDN network, and the modem-chip route is one way to get in on the ground floor of what is expected to become a very lucrative niche.

Another new entrant, Fairchild Semiconductor Corp., "has been working for years to get into the telecommunications market with functional-specific dedicated products," says Christopher Nehhan, communications products marketing manager at Fairchild's Analog Division, in Mountain View, Calif. The modem chip arena is Fairchild's second and most recent foray into the telecommunications arena. The company introduced a single-chip modem in November of 1985, and according to Nehhan, the product already has 80 design wins and 25 are currently in the production phase.

In the modem chip marketplace, one of the most successful players, and the oldest, has been Rockwell International Corp., which, according to a Gnostic report has an estimated 55% share of the market for chip-level modems. "Semiconductor companies have to migrate or evolve to become more communications oriented," says Marilyn Suey, director of marketing for Rockwell's Semiconductor Products Division in Newport Beach, Calif. Rockwell, Suey points out, "has one foot in semiconductors and one foot in communications, and is trying to meld the two."

The Japanese connection

In fact, Rockwell's success extends far beyond American shores. Several years ago Rockwell broke into the Japanese marketplace by making customized facsimile modem boards for both Matsushita Electric Works Ltd. and Ricoh Company Ltd. Today, according to Suey, Rockwell sells to "every major Japanese facsimile modem manufacturer." Suey also estimates that Rockwell has sold into Japan more than one million of its R96FAX facsimile boards — a product that began initial shipments in early 1985. Rockwell also sells high-speed device sets — 2,400 bits per second (bps) — and board-level products into Japan.

In the modem chip marketplace, one of the most successful players, and the oldest, has been Rockwell International

Another player that has made it through the doors of Japan's modem arena is Silicon Systems Inc. Silicon Systems recently inked a deal with Japan's Oki Electric Industry Company Ltd. Under a licensing agreement, Oki will manufacture and sell a number of Silicon Systems' modem chips. This makes the Tustin, Calif., firm the only player in the modem chip arena to have a second-source agreement with a Japanese firm, claims Carmelo J. Santoro, Silicon's chairman and chief executive.

This venture in Japan is not the firm's first, however. According to Santoro, $17 million, or 25% of his company's $67 million in 1986 revenue, came from Japan.

Fairchild, likewise, is hoping to extend its success in selling chips in Japan with its newly announced line of single chip modems. "We already have a number of design wins in Japan" for the company's 1,200bps single-chip modem, says Fairchild's Nehhan. These chips will either be built into PCs or PC accessories such as standalone modems or plug-in cards, which will then be imported into the United States.

Customer shifts

In addition to overseas opportunities, both modem component and modem-box manufacturers are finding new customer opportunities due to the growing trend away from standalone modems and toward the integration of modem capabilities into larger systems.

Within three short years, the customer base for application specific modem chips at ASIC manufacturer Silicon Systems has shifted from "third-tier companies making auto dialer parts . . . to *Fortune* 1000 customers, [including] AT&T and IBM," says Santoro.

At Rockwell, there has been a "significant increase in RFI's [requests for information]" coming from workstation and systems manufacturers, says Suey, who estimates that the current mix of RFIs is about three workstation and systems manufacturers to one traditional modem manufacturer.

Rather than hurting the traditional modem manufacturer, however, this trend seems to be benefiting them as well. Karl Zorzi, vice president of datacommunications products at Racal-Vadic, based in Milpitas, Calif., estimates that during calendar year 1986, approximately 12% of his company's business came from sales to original equipment manufacturers (OEMs). This compares with about 6% the previous year. He also expects his OEM business during 1987 to "go up at least half, if not double" that of last year.

This increase in sales to OEMs is also translating, on the other end, into increasing component purchases. During 1986, Zorzi estimates that Racal-Vadic, a subsidiary of Racal Electronics Ltd. in England, purchased "in excess of a quarter of a million chips," for modems, and he expects that during 1987 that number will increase to about 350,000. In addition to using proprietary components, Racal-Vadic also purchases chips from a variety of semiconductor vendors, including Rockwell, Intel, Silicon Systems, Sierra Semiconductor Corp. and Exar Corp.

CAROL SUBY

What's hot and what's not in workstations

CASE and electronic publishing are joining CAD/CAE as the high-growth segments of the U.S. workstation market

By David Card

Engineering workstations became a real live billion-dollar business last year. The fastest growing computer market held up in the face of an industry slump, and should continue to cruise along in 1987. High-growth industries tend to have common trends, and this one will be no exception. Prices will drop and market share will consolidate in the hands of a handful of players, while new applications, such as publishing and software engineering, will solidify.

Sales should reach $1.86 billion in 1987, forecasts market research firm International Data Corp. in Framingham, Mass. IDC analyst Vicki Brown says that unit sales are way up, but that the average selling price of a 32-bit, graphics-oriented, networked single-user computer (IDC's definition of a workstation) shriveled from $30,000 in 1985 to $22,000 last year.

Two key markets emerging this year are electronic publishing and software writing — usually referred to as CASE, for computer-aided software engineering. These applications do not need the high-performance color graphics required by design automation, which is still by far the biggest segment of the workstation market.

One of the big surprises of 1986, IDC's Brown also says, was the emergence of Hewlett-Packard Co. as the workstation leader, although other analysts, including Dataquest Inc. of San Jose, Calif., say Apollo Computer Inc. of Chelmsford, Mass., and Sun Microsystems Inc. of Mountain View, Calif., still dominate the market.

HP, which does not break out its workstation sales but agrees with IDC's conclusions, says its strength was not in selling to design engineering, the traditional destination for workstations. Instead, HP found new homes for workstations, on the factory floor and in the lab, as controllers for clusters of HP instruments. Measurement automation "is becoming a smaller proportion of our sales as other markets like design automation and software engineering come up," reports William Parzybok, vice president and general manager of HP's Engineering Systems Group in Fort Collins, Colo.

CASEs in point

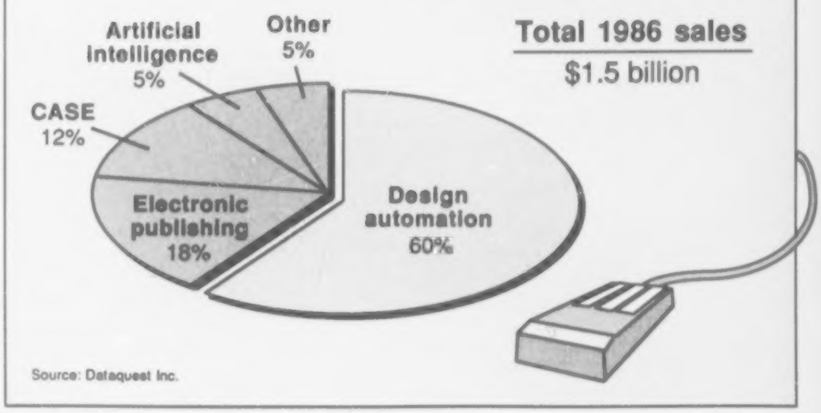
For some analysts, however, including Dataquest, Sun is the undisputed leader in electronic publishing and CASE. Sun president Scott McNealy says that he sells CASE stations to what he calls "internal OEMs," rather than through regular original equipment manufacturers. "More often than not it's an EDS or a Boeing or a Lockheed or a Hughes or somebody like that who's got thousands of software engineers," he says.

"The other area is AI," McNealy says, referring to artificial intelligence. "It's not necessarily a market, but a technology that's probably going to drag us into a lot of weird markets that we wouldn't have gotten into."

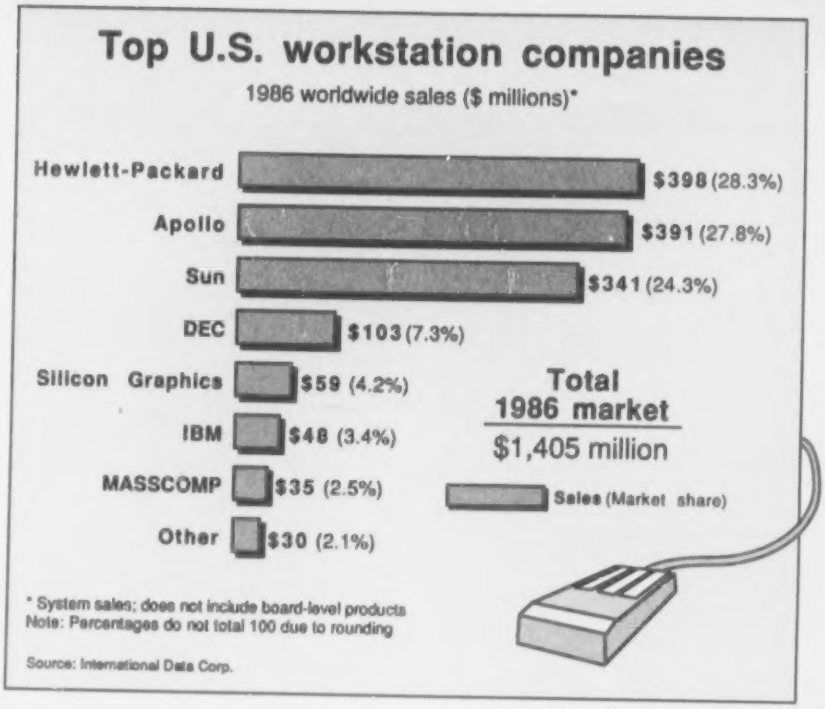
Not surprisingly, McNealy is more excited about the design markets than Sun's current strongholds. Some of those internal OEMs have been using their Suns to write software for computer-aided design, manufacturing and engineering (CAD/CAM/CAE). The CAE and CAD markets have been a little sluggish lately, but will bounce back, McNealy says. "It comes in cycles, and maybe we're down at the bottom, but I see a lot of good development going on," McNealy says. "I haven't given up on it at all."

Design automation is still the major market for workstations

Workstation sales by end market



Source: Dataquest Inc.



* System sales; does not include board-level products
Note: Percentages do not total 100 due to rounding

Source: International Data Corp.

Anxious to add Sun to its list of original equipment manufacturing (OEM) suppliers is CAE/CAD vendor Racal-Redac Ltd. of Tewkesbury, England. The firm just signed a $25 million extension to its deal with Apollo. Redac also sells systems based on machines from IBM and Digital Equipment Corp. But Redac chief executive Ian Orrock likewise sees Sun as a powerful contender in Europe, Japan and Scandinavia, due to its OEM arrangements with major computer vendors in those regions. "Sun's greatest strength," Orrock adds, "is its software tools."

Apollo, however, late last year struck a blow into Sun's CASE heartland, landing a contract for some 130 workstations for the Software Productivity Consortium. The Consortium is a group of 14 defense contractors — including Allied-Signal Inc., Martin Marietta Corp., TRW Inc. and United Technologies Corp. — founded in September 1985 to streamline and regulate the process of writing software for military systems.

"Since it was not a government procurement, we were free to write a sensible RFP [request for proposal]," quips John Githens, vice president for the Consortium's Environmental Engineering division in Reston, Va. Githens likes Apollo because "they were not just a workstation and/or network vendor." He particularly likes the performance of Apollo's proprietary Domain network. But the Consortium would not have gone with Apollo if the company had not "opened up their network," with ties into networks and hardware from other suppliers.

He says that Apollo was "more forward-looking" and — surprise — more aggressive on pricing than Sun, usually regarded as the low-end leader. Githens says DEC also bid on the contract.

Publishing for dollars

Electronic publishing is also proving to be a boom market for workstations, accounting for 18% of 1986's sales, or $270 million, according to Dataquest. Two years ago, that share was only 13% for a $55 million total. Start-ups and established companies alike are rushing to offer software for the layout and design of publications, both for internal consumption and distribution [ELECTRONIC BUSINESS February 15, 1987]. Xerox Corp. was big enough to offer its own workstation as a publishing engine, with its proprietary microprocessor and operating system. But most workstation companies have rallied around the 68000 series of chips from Motorola Inc.

The rise of electronic publishing, meanwhile, has opened up new opportunities for third-party software companies and system integrators. Interleaf Inc. of Cambridge, Mass., for example, offers software for Apollo, DEC and IBM workstations as well as Sun. "Our decision proved right in hindsight," Interleaf marketing vice president George Potter says of opting out of the proprietary hardware business. "Apollo ships in a week what we ship in a year," he says, for example. This way Interleaf can concentrate on software development. At the same time, Interleaf competitor Texet Corp. of Arlington, Mass., last year switched from homemade hardware to Sun, says president Al Ireton, just in time to land a deal with typesetter supplier Compugraphic Corp., which was working on its own Sun-based system.

Another new market for workstations is financial analysis

Another new market for workstations, one with "the potential to be the biggest market in this industry," according to IDC's Brown, is financial analysis. "One of our largest single orders for workstations came from a non-engineering market, namely a large banking institution," says Richard Lewan, a marketing manager at DEC in Marlboro, Mass. Lewan says that the computing requirements of financial analysts — number-crunching on the desktop, multiple windows onscreen, tight networking — duplicate those of engineers. "You talk about these people moving billions of dollars around," he says. "They're not afraid to spend some money on a workstation."

The players

As the market matures, the hardware from the players in the workstation arena is getting more and more difficult to differentiate at a casual glance, according to Dataquest analyst David Burdick. Apollo used to be "The Proprietary One" and Sun, with its emphasis on the Unix operating system and Ethernet network, "The Standards One." Now, Apollo offers its version of Unix. HP always did. Standardization will not be a sales pitch in 1987 "because everybody's got it," predicts Edward Zander, Apollo's vice president for corporate marketing.

All three firms — Apollo, HP and Sun — use the 68020 chip from Motorola, but Parzybok hints that it would not be unreasonable to expect Hewlett-Packard to adopt its so-called Precision Architecture — based on proprietary reduced instruction set computing (RISC) chips. The 68030 is due early this summer, Burdick says, and its ready-made 68000 series software base will discourage the workstation companies from looking elsewhere. The Intel Corp. 80386 is starting to ship, but the three leaders all claim disinterest.

Burdick of Dataquest also predicts that, as the machines become generic, marketing will be the distinguishing factor. Salesmanship will become increasingly important, he says.

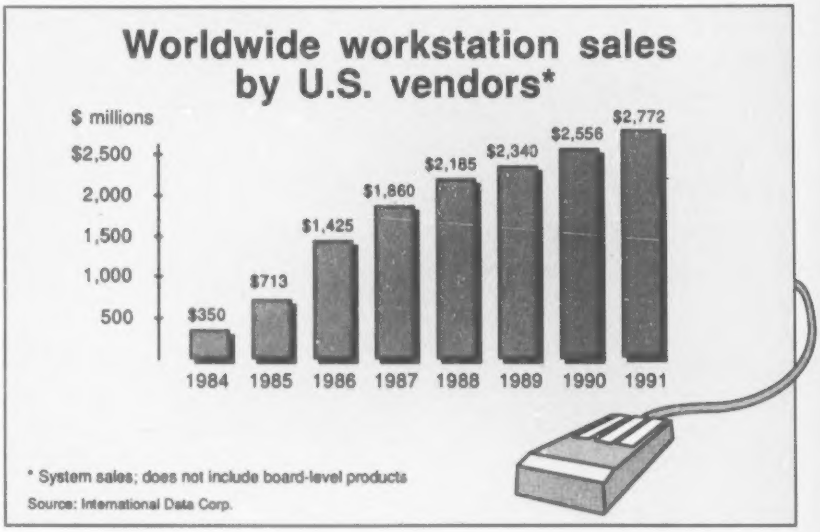
Among the crowd, Silicon Graphics Inc. of Mountain View is "a company to look out for," according to Burdick. Silicon Graphics has staked out a cozy niche for itself at the highest end of the workstation market. The company sells 3-D graphics machines running $40,000 to $60,000 into markets such as mechanical CAE, animation and visual simulation. "At the high end, they are starting to be considered a mainstream application and architecture, and they are certainly recognized as the leader there," Burdick contends.

Dana Computers Inc. and Stellar Computer Inc. are two start-ups whose principals include famous names from Convergent Technologies Inc. and Apollo, respectively. Both firms profess to deliver by the end of the year ultra-high end graphics engines. Silicon Graphics director for product marketing Craig Olson says he thinks these two could price themselves out of his market.

"I don't see how they could possibly catch Silicon Graphics," IDC's Brown says. Olson adds that the "three key players," to his mind Apollo, DEC and Sun, are not competing in his market yet. His firm currently has an OEM deal with Control Data Corp.

Another new contender in the workstation world is MASSCOMP Corp. of Westford, Mass. "The primary difference between us and most of the others is that we supply product to people that sell workstations," according to Douglas Rowan, vice president for domestic sales and marketing. Harris Corp., and Unisys Corp.'s Graftek subsidiary, for instance. This was not always the case. Before MASSCOMP located its niche in real-time computing and data acquisition, it lost money trying to compete in the general purpose market.

In his business, Rowan says, he runs into DEC and HP as competitors. Right now, MASSCOMP is teaming up with Sun in competition for a 4,000-workstation contract to the National Security Agency, the U.S. hush-hush communications spy agency. Systems Development Corp., a Unisys systems integrator, is bidding the pair against Apollo, and another integrator is bidding IBM hardware, according to Rowan. He says that the NSA spec'd a two-part buy, with the general-purpose machine based on Apollo, and the real-time machine based on MASSCOMP. The winner is expected to be announced this month.


Worldwide workstation sales by U.S. vendors*

* System sales; does not include board-level products

Source: International Data Corp.

Four more to watch

Intergraph Corp., the Huntsville, Ala., CAD/CAM company, is known for picking smart hardware strategies — Intergraph was an early DEC OEM. So president James Meadlock did not exactly shock anyone when he steered Intergraph away from hosts to a distributed Unix workstation-based setup. But he did when he opted to build his own, especially with the Fairchild Semiconductor Corp.'s Clipper chip as its heart. "It doesn't make sense to run Unix on a DEC workstation," is Meadlock's reasoning.

Smart money would not count either DEC or IBM out of the race

Now Intergraph is upping the voltage of its shock, with its January announcement that it is plunging wholeheartedly into the general-purpose workstation business. All of this mere months after denying any interest in the OEM market because of the "friction point" between OEMs and the systems suppliers that buy from them. Up until now, workstation sales, bundled with software, have been a little disappointing, Intergraph admits.

Prime Computer Inc. in Natick, Mass., is another CAD/CAM company, at least for a big part of its minicomputer business. Prime promised a workstation a year ago, but so far has not delivered. "It's got to be really hurting them," Brown says. Another minimaker, Data General Corp. of Westborough, Mass., has a strong CAD/CAM presence. "Compared to Apollo and Sun and even Digital, we're a little later getting into this market," admits director of product marketing John Scanlon. "But we have a strong customer base to build on."

The Macintosh personal computer from Apple Computer Inc. of Cupertino, Calif., is not a workstation by any means. However, the rumored second generation Mac will almost certainly contain the same Motorola chip powering most of the machines. Apple's vice president for new business developments, John Scull, will not comment on the subject, nor whether Apple will target workstation markets. But he does say "there is absolutely no question that the power of a workstation will move to the desktop."

Meanwhile, CAE market leader Mentor Graphics Corp. sells systems based on Apollo computers. Vice president Gerald Langeler is keeping a weather eye on Apple from his base in Beaverton, Ore. "It's going to be a very capable product," he says of the next Mac, "every bit as good as the '386 PC. And it may have some goodies that the '386 doesn't have. But it's not clear that they're going to make a big thrust" into CAE.

What's missing from this picture? DEC and IBM, that's what. "Both of these companies did surprisingly poorly," IDC's Brown contends. "The problem DEC and IBM face is, are they going to eat their own children?" Burdick explains — meaning that newer machines could rapidly obsolete their current product line. He says that the two, as leaders in host-based computer systems, are having a hard time managing their way into distributed computing. Or even deciding if that is what they want to do.

In DEC's case, "surprisingly poorly" is a relative term at best. Both analysts count only complete workstations, that is, a computer with graphics. DEC has only offered a color graphics workstation for a year. It has sold at least 25,000 of its MicroVAX II board-level products, Burdick estimates. But he does not count those sales as workstations, because he says most customers are using the MicroVAX II as a three- or four-person mini-host. DEC fans will point out that any dollar spent on a MicroVAX II will not end up in the pockets of Apollo, HP or Sun.

Apollo admits as much. "In technical markets, DEC is the incumbent," Zander says. Besides a massive software base running under its VMS operating system (the MicroVAX can support it or DEC's version of Unix), Zander says DEC is perceived as a safer buy than the younger companies. "Where DEC will win — and they do win — against us, is in the corporate sell," Zander says.

DEC also has no shortage of OEMs. Nearly everyone who sells something that runs on any one workstation, also sells it on the MicroVAX. Smart money would not count either DEC or IBM out of the race.

And from the East . . .

Workstation vendors cannot help but give a glance now and then to the Far East. Nearly every Japanese computer company has announced some kind of a workstation, but few have arrived in the United States. Most follow the Motorola/Unix strategy.

To date, however, NEC Corp. is the only Japanese company to bring a workstation to the United States. NEC, which had been embroiled in a messy microprocessor patent infringement suit, stuck to a dual-Motorola chip design for its workstations. "We just wanted to stay in a standard architecture," says Frank Girard, vice president for systems marketing for NEC's American sales arm in Boxborough, Mass.

With a moving video-oriented product, NEC will focus on the automotive and aerospace industries, going after large companies with deep pockets, rather than trying to sign up OEMs, Girard says.

Meanwhile, Japan's Ministry of International Trade and Industry's Sigma project has started to produce workstations as well. And another state-sponsored effort is coming up with a Unix competitor called TRON. That is something way off, Sun's McNealy says. "Let's assume they get it done and they announce it," he says. "It's still going to take another seven or eight years to have it all ready. The industry, practically, is behind Unix. There is not a major company in the industry today that doesn't have Unix in its product line. TRON is going to be a while and there will be time to react." □

Whither Armonk?

IBM introduced its RT PC — for reduced instruction set computer (RISC) technology — in January 1986 with, for Armonk, no small fanfare. The RT, IBM's workstation, has so far proved something of a flop.

"It has clearly been a very, very big disappointment," says analyst David Burdick of Dataquest Inc., San Jose, Calif. He estimates only 3,000 to 5,000 were sold last year, concluding that the figure is closer to 3,000. "In technical markets you can't get too cute with not having leading-edge performance," Burdick contends. "It has a third to a fifth of the average floating point performance, no networking and clumsy graphics."

"It is not a technological barnburner," agrees Vicki Brown, an analyst with International Data Corp. (IDC) in Framingham, Mass. She expects IBM will correct most of the RT's performance deficiencies in early 1987. Still, without the software or original equipment manufacturers (OEMs) many expected to dog the RT, it will be 1988 before IBM has any significant effect on the market, Brown says.

Valid Logic Systems Inc., a San Jose computer-aided engineering (CAE) company, was one of the first to announce its intent to support the RT. Valid still has not offered an RT-based system. Marketing vice president David Foster runs some software on a proprietary workstation and some on Digital Equipment Corp.'s VAXstation.

"Once CV [Computervision] and others had a move to consider the RT. That has really fallen off," admits Bardwell Salmon, marketing vice president for Computervision Corp. in Bedford, Mass. CV is betting on a Sun workstation to power most of its computer-aided design/manufacturing (CAD/CAM) software. Likewise, Robert Lodi, marketing vice president for VIA Systems Inc. of Chelmsford, Mass., which sells CAD software for integrated circuit design on computers from Apollo, DEC and Sun is unimpressed. "The RT has no advantages in the engineering business," Lodi claims.

Apollo's Zander says that the RT's effect on his business has been negligible. "What a yawn. Everybody always tends to project doomsday scenarios from product announcements," he says. IBM, he thinks, may be "forgetting about our little dinky part of the business. What is it, even if it grows to $3 [billion], $4 billion, compared to the overall computer industry?"

Even though IBM may have sold more RTs than some of its other competitors suspect, DEC's Lewan says he's not worried either. Lewan claims that his customers have a performance "checklist" with minimum requirements for graphics, networking, power and price — none of which the RT meets.

"This will be the year to tell whether IBM will be a strong contender with the RT — whether it will be the RT or the '386," says Brown of IDC. She says that any potential workstation based on Intel Corp.'s 80386 chip would come out of a different division within IBM. The two would end up competitors. "It's not out of the question that IBM would drop it," she says of the losing product. Dataquest's Burdick agrees that this is the year to ask, "Is the RT part of the long-term equation?" He points out that at the end of the RT introduction last year, IBM quietly announced the discontinuation of its 9000 series.

IBM declined to be interviewed for this story. □

Can high tech make it in Massachusetts?

A poll of 1,099 executives, who work in Massachusetts, suggests all is not well in the land of the bean and cod

High-tech executives have strong opinions about what it is like to operate in one of the country's industry meccas — Boston's Route 128 area. And their opinions don't always agree with the prevailing political and economic beliefs.

A recent survey conducted by ELECTRONIC BUSINESS magazine revealed that managers in technology companies are most annoyed with politicians who take credit for the state's economic revival. They are also appalled by what they describe as the poor condition of the state's infrastructure — despite high taxes. In particular, many executives singled out recently reelected Governor Michael Dukakis, who is now gearing up for a run at the presidency.

Asked what was the most important factor limiting the growth of high tech in the state, a resounding 38% cited taxes. Many residents, indeed, cynically refer to the state as "Taxachusetts." The state has a 9.5% corporate tax on net income; a 5% tax on individual earnings; and a 10% tax on unearned income, such as interest and dividends.

On the positive side, however, nearly three out of four of the respondents thought the outlook for the high-tech economy in the state was either excellent or good. Many praised the state's academic institutions and "quality of life." Others indicated that they believe that Massachusetts will continue to shine as a center for innovation and research.

The ELECTRONIC BUSINESS survey was based on questionnaires mailed late last year to 4,000 executives at several hundred Massachusetts electronics companies, mostly smaller firms with annual revenue of between $5 million and $25 million — although executives at major corporations (such as Data General Corp., Digital Equipment Corp., General Electric Co., Prime Computer Inc. and Raytheon Co.) were also polled. Of the 4,000 executives selected from our circulation list, 1,099 responded, for a response rate of 27.5%. Those responding were not necessarily residents of Massachusetts. Some lived in neighboring New England states, primarily New Hampshire, and commuted to work in Massachusetts.

> The survey revealed that managers in technology companies are most annoyed with politicians who take credit for the state's economic revival

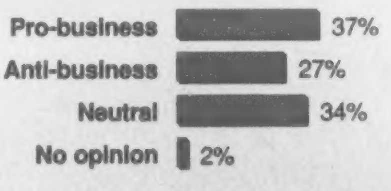
We believe the poll may be indicative of not only how small electronics companies rate the state, but of how Massachusetts businesses, in general, feel. A recent study by Massachusetts Institute of Technology's professor David Birch, for example, shows that of the 30,000 jobs that were created in Massachusetts in 1986 the great majority were in firms with fewer than 20 employees. And according to our 1,000 or so respondents, the problems most frequently cited by economists in a growth economy — shortage of labor and high wages — are nowhere near as important as other issues confronting small businesses in the electronics sector.

"Lower wage rates may influence a company's choice of location for manufacturing plants, but high-tech manufacturing is less and less labor intensive," wrote one engineering manager who, like many in the survey, asked not to be identified.

The respondents, however, were split on the effects of the state's low unemployment rate, which was 4.2% in November, and the reported shortage of labor. Some 47.6% of the respondents said their firms were having difficulty hiring; 47.7% said that they were not. When asked what kinds of jobs were most in demand, most of the respondents checked off engineering, production and marketing, in that order. But a number of other skills were also mentioned, including telemarketing help and machinists.

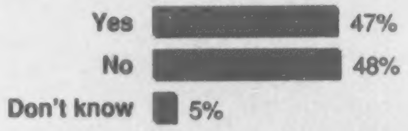
A big fear in Massachusetts — and indeed, in the United States — is that much of production manufacturing is migrating to low-wage areas of the world. When asked whether other states or countries with lower wage rates would be successful in luring the

In general, the government of Massachusetts is:



64% of those responding said the state government should take a more active role in fostering high tech; 3%, a less active role; 31% favored a hands-off policy; and 2% had no opinion.

Is your firm having difficulty hiring personnel?



42% of those responding said that they had difficulty filling engineering jobs; 20%, production jobs; 15%, marketing jobs; 10% clerical jobs; and 6% administrative jobs.

electronics industry away from Massachusetts over the next five years, 62.5% of the respondents said yes; 26.4%, said no.

Some noted an indirect effect of the state's high blue-collar wage rates. "Our company has seen two large customers relocate in South Carolina recently because union-backed demands for increased benefits and salaries jeopardized the companies' future," wrote the chairman of a small firm.

To some, however, the labor pool in Massachusetts was seen as a plus. When asked to name the single most important positive factor in fostering growth in the state's technology sector, one marketing manager indicated the "people," whom he described as "bright and well-educated."

Some respondents, however, said that finding certain types of skilled labor is a problem for their firms. "If the state leaves us alone," wrote the chairman of one company with what was a typical caveat, "the major future problem will be availability of nonprofessional labor and the inability to recruit professionals from outside of Massachusetts due to much higher real estate costs." As of October 1986, for example, the median sale price of a single-family home in Boston rose 19% to $165,600, compared with a national increase of 4.3% to $79,900.

However, "Massachusetts will remain a key R&D [research and development] area because of its university base and quality of life," argued David Wheeler, president of Intersell Inc., an electronic manufacturers' representative in Burlington, Mass. "Some production will always leave for lower wage rates."

Many respondents also said that the high cost of living in Massachusetts is a considerable factor in driving away production workers. "Manufacturing will move [out of the state] as the cost of living and housing makes manufacturing people less available," warned one vice president for manufacturing.

"Real estate prices, congested traffic [and the] high-tax reputation make it almost impossible to hire a candidate from outside the Northeast, if the candidate is also considering another area of the country," added another marketing manager.

Respondents said that the high cost of living in Massachusetts is a considerable factor in driving away production workers

After the cost of living, apparently nothing so arouses the ire of high-tech executives as traffic and road congestion. Although the survey made no reference to either one, a number of respondents made a special point of mentioning the hassles of commuting to work on Boston's crowded roadways.

When asked to name the single most important factor limiting growth in Massachusetts, one vice president at a large company said laconically: "Poor infrastucture. And worsening roads, airport."

Others were more explicit: "The place is falling apart," wrote the chairman of one medium size firm. "Boston traffic must be fixed. Commuter rail must be run more often, by professionals, not union thieves. Highways need much more work, and a smart person to figure out how! Less politics, more action."

The cost of government also turned up fairly frequently as a complaint on our survey. One marketing manager cautioned that "the liberal politics and fiscal policies of the current administration will result in problems in the future. We are walking a fine line in terms of the overall state economy and employment. A misstep could result in a very bad fall."

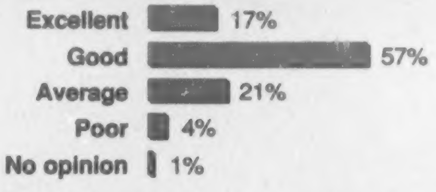
Added another executive: "Governor Dukakis has increased government expenditures excessively in the past four years. Should the state experience a slump, however temporary, the high level of expenditures and expectation created by them will again create an onerous tax environment in the state."

Others thought the Massachusetts government should be doing more to improve the climate for high-tech business. T. Cronin, president of Cronin Electronics Inc., a Needham, Mass., distributor, said the state should be "more active" in fostering high-tech industries — "but only if they understand and really believe [in it]." Dukakis, he added, "doesn't really believe and doesn't understand [business]."

Upbeat outlook

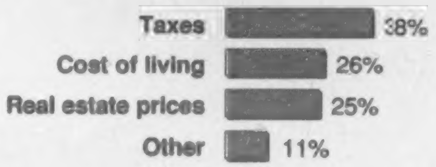
Some respondents were upbeat, however, about the state's government, citing the success of past programs as indicative of a positive future. "Our strong high-tech collegiate base, coupled with government assistance in establishing high-tech learning centers and industrial liaisons with both, should continue to foster increased growth in high tech," wrote David Krigman, manager of manufacturing technology at Lifeline Systems

The outlook for the high-tech economy in Massachusetts is:



Although a majority of respondents characterized the state economic outlook as either good or excellent, 63% predicted that lower wage states (or countries) would be successful in the next five years in luring high-tech industry away from Massachusetts.

What is the single most important factor in limiting high-tech growth in Massachusetts?



In the "other" category, respondents frequently cited traffic congestion, poor roads and a deteriorating state infrastructure.

Inc., a small manufacturer of emergency response systems in Watertown, Mass.

But most business people were skeptical of the state government's efforts to aid the high-tech industry. "The Massachusetts bureaucracy is one of the most inept I've ever encountered," wrote one marketing manager. "Dukakis should encourage more interaction and joint problem-solving efforts among business and academic institutions."

"Companies have to work around politicians trying to help them," said a vice president for engineering. Griped still another: "The blue collar/liberal orientation of Mass., government is contrary to high-tech growth." He cited "unionization, high taxes, high spending [and] cronyism."

Where credit is due

But no issue so infuriated respondents as their perception of politicians as opportunists who try to take credit for the state's economic revival. Most of the respondents, in fact, seemed to resent Michael Dukakis (D), who was re-elected in November by a whopping margin (72%) over George Kariotis (R).

"Governor Dukakis has done little to support high tech. The growth in the Mass., economy happened as a result of business initiatives and a stable federal government," wrote a vice president for engineering.

"When a state has a surplus of over $900 million after increasing its budget over 30%, the administration and legislature can no longer govern. They have been fiscally irresponsible and the business community pays," wrote Chris Alex, president and chief executive of Hybrid Packaging Tech Corp., Waltham, Mass., makers of thick-film hybrids for integrated circuits.

Another topic that drew heat was Proposition 2½, a popular state referendum that limited property taxes to two and a half percent of the assessed value of real estate. The referendum was backed by industry groups, which said that capping property taxes would help make Massachusetts industry more competitive. Dukakis, however, was castigated for his failure to support the measure.

> Respondents observed that the state's 200-plus colleges and universities had more to do with the state's economic success than political policy or lack of it

Proposition 2½, right-to-know [legislation], plant closing [legislation], etc. stamps him as antibusiness," said one marketing manager. Other criticisms were leveled at the attempts by Dukakis officials in previous years to levy a tax on software as a product.

Other respondents also observed that the state's 200-plus colleges and universities had more to do with the state's economic successes than political policy or lack of it. "High tech in Massachusetts was a spin-off of the universities and [MIT-affiliated] Lincoln Labs," wrote one marketing manager. "The state had nothing to do with the early years."

Still others credited industry groups for influencing state government. One chief executive of a large company said that the Massachusetts High Tech Council (a coalition of companies in the greater Boston area) "does more to foster high tech than does the state. It is a pity that state government views MHTC as an adversary, rather than an ally.

A few respondents were downright gloomy about the state's high-tech future. "High tech peaked in 1985 in Massachusetts," wrote the chairman of one company. "From this point on, [it's been] a long downward slide."

Some pinned Massachusetts' future to the computer industry. The "outlook for high tech may remain good if the computer industry rebounds," commented one Massachusetts marketing manager, "if not, you may see more layoffs and cutbacks in 1987. Competition in high tech is becoming stronger."

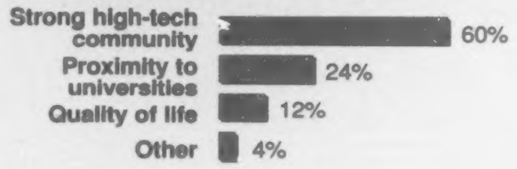
A Massachusetts-based securities analyst, who tracks the electronics industry, warned: "A shakeout in the high-tech industry could devastate the economy of Massachusetts in a manner similar to that brought on by oil price cuts in Texas."

But for every three gloomsayers, there was at least one bright commentator. Robert Ravenstein, for example, president of Bomara Associates, a software manufacturers' representative in Chelmsford, Mass., pointed out that Massachusetts may look good by comparison with other areas: "We are a sales office," he wrote. "Our principal companies are in California. Massachusetts is now the best source of revenue for these companies because of the slowdown in California."

THERESA ENGSTROM and
KATHLEEN E. HEPBURN

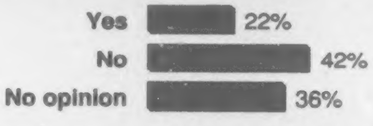
Engstrom is a Boston-based business writer. Hepburn is an assistant production editor at ELECTRONIC BUSINESS

What is the single most important factor in fostering high-tech growth in Massachusetts?



In the "other" category, numerous respondents cited the state's proximity to New Hampshire, which sports one of the most favorable tax climates in the nation.

Does the supposed "liberal orientation" of the state's congressional delegation affect the ability of local companies to win government contracts?



33% of those responding said Tip O'Neill's retirement as speaker of the house would make it more difficult for Massachusetts companies to win government contracts or influence high-tech policy in Washington; 46% said it wouldn't; and 21% had no opinion.

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Electronic Business

Xerox: The quest for quality continues

Contract manufacturers and surface mount technology

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Why Computervision's Gable is not out of the woods yet

Canadian Electronics

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Sales growth has a foreign ring

Foreign sales may keep U.S. companies' sales advancing this year. Profits are another story

In most industries it may be a habit to push shipments out the door at the end of the fiscal year. In the electronics industry it is a passion that has been developed into an art. Since most electronics companies are on a calendar year, sales peak in the fourth quarter, followed by the second quarter push, by companies whose year ends in June. Every year since 1975 when ELECTRONIC BUSINESS started tracking sales and profits by U.S. electronics companies and distilling them into the indexes that appear on this page, fourth quarter sales have surpassed the previous three. So it was not surprising that the index for revenue ended the 1986 year at its highest value ever.

What was surprising is that the fourth quarter peak in sales was relatively modest — less than 2% higher than 1985's and only 22% higher than the second quarter. Thus, revenue for 1986 was ahead of revenue for 1985 by a meager 4%, the smallest annual growth since we started the index, earning for 1986, for most companies, the dubious reputation of having been the most difficult year in recent memory.

Moreover, the main engine that propelled sales last year was outside the country. Had it not been for its foreign sales, IBM would had seen a decline in revenue last year for the first time in more than four decades. As it was, it registered only a gain of slightly more than 2% for the year. The fourth quarter did not help, as revenue was off 1% with respect to the year-earlier quarter. Foreign orders grew by 30% for Hewlett-Packard in November and December, according to president John A. Young. Among the 16 companies that make up the industry sample on whose revenue and profits we base our indexes, the major one whose sales growth in the United States matched growth from international sales was Digital Equipment Corp. It is likely that this scenario will be repeated in 1987. Indeed, many companies pin their hopes for 1987 on foreign sales and look to the weak dollar as a major weapon to gain foreign orders.

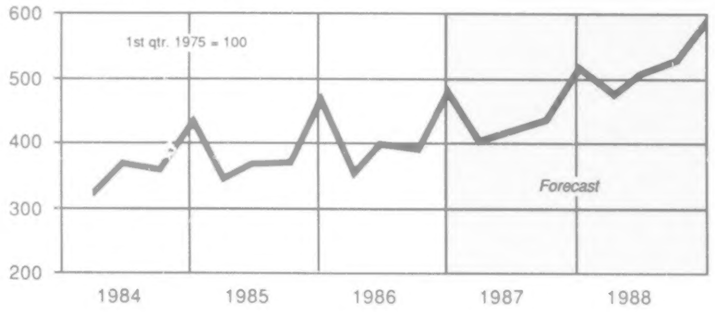
Profits are another story. The index for profits declined by 25% last year with respect to 1985. That year, in turn, had seen profits drop by 17% with respect to the record year 1984. The index reflected not only IBM's eroding profits — they dropped 27% in 1986 — but also the red ink at semiconductor companies. The semiconductor segment, however, will probably be the first to recover in 1987. Although profits by chip makers will be under severe pressure from low chip prices, at least growing sales promise to lift their income into the black.

Using the Cahners Early Warning Indicator, Cahners economist Cheryl Patstone forecasts a 10% growth in revenue by a much better improvement, 21% in profits. Judging by brisk sales in the first quarter, Patstone's forecast may turn out to be on the mark. Proof is coming soon, when the figures for the first quarter of 1987 become available later this month.

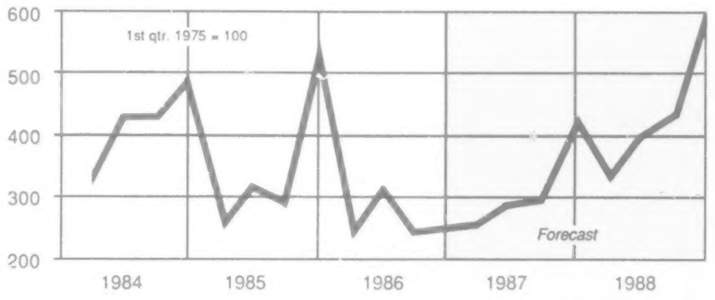
ALBERTO SOCOLOVSKY

Electronic Business

Revenue index



Profit index



Historical data: Dow Jones News/Retrieval
Forecast: Cahners Economics

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, showed a mild decline in the second quarter, followed by a slight recovery in the third quarter. For 1986, production is expected to be up a scant 0.9% from the previous year. This year, steady improvements are forecast thoughout the year pushing production up 3.9%.

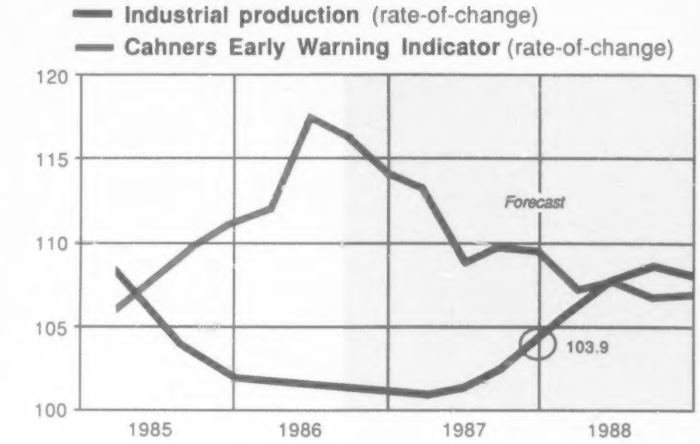
The Cahners Early Warning Indicator (CEWI) is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index. It forecasts probable business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 103.9 level forecasts using the CEWI for the end of this year indicates that the average for all of 1987 should be 3.9% above 1986.

Readers can obtain a brochure explaining the CEWI method from Cheryl Patstone, economist, Cahners Economics Department, 3021 Tisch Way, Suite 100, San Jose, Calif. 95128.

ATE revenue and profit

In the third quarter of 1986, revenue for automatic test equipment manufacturers showed an 8% increase from the prior quarter and was up 9% from the year-ago quarter. This was the first quarter-to-quarter gain since the beginning of 1985. The gradual improvement in the third quarter along with fourth quarter revenue is expected to show an even sharper increase when demand from computer and semiconductor manufacturers for automatic test equipment strengthens, which seems to signal a climate of cautious expansion. Following a strong 42.4% gain in 1984, sales fell 14.4% in 1985. Despite a gradual improvement in the second half of 1986, revenue is expected to drop 2.7%. This year a 12.2% increase is forecast, followed by a sharp 25.3% rise in 1988. Earnings of ATE manufacturers showed a slight profit for the first time in over a year. Profits are expected to continue to strengthen throughout the next two years.

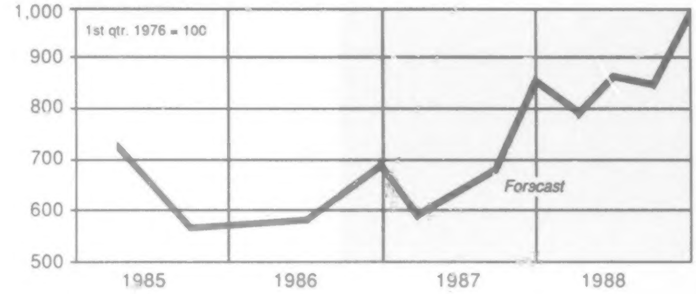
Economic indicators



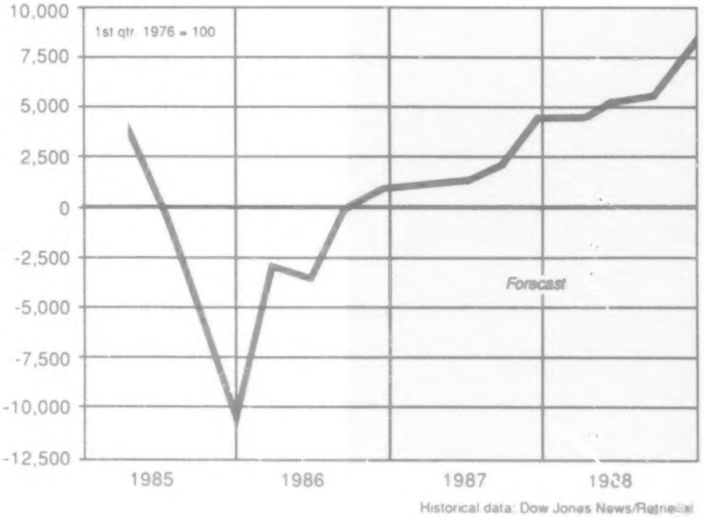
Historical data: Federal Reserve Board
Forecast: Cahners Economics

ATE indexes

Revenue



Profits



Historical data: Dow Jones News/Retrieval
Forecast: Cahners Economics

Surface mount technology is reviving contract assembly

Contract manufacturers are investing heavily in SMT. Already, many say they are reaping the rewards

U.S. contract assembly houses, already benefiting from a strategic industry-wide move back to domestic manufacturing [ELECTRONIC BUSINESS Sept. 15, 1986 p28], are opening another market window that promises to accelerate the trend toward onshore production. That window is surface mount technology (SMT), assembling components directly on the surface of a printed circuit board (PCB), rather than soldering them through plated holes. The result is smaller, denser, higher performance PCBs.

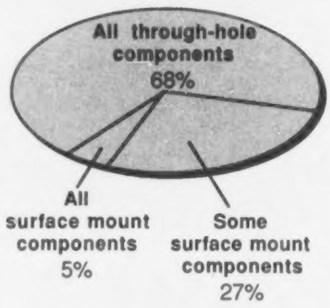
Although SMT is a complex, process-intensive technique, involving ultratight design rules, expensive and often unreliable machinery, and a paucity of packaging standards, most large contract manufacturers say that they have invested millions of dollars over the past two to three years to bring on full SMT production capability. The risks are great, contractors concede, but the risks of remaining on the sidelines are greater. Even though the big push to SMT has yet to reach full steam — only 3% of all integrated circuits (ICs) consumed last year were in surface mount packages — those contract manufacturers that have taken the plunge report that SMT is by far the fastest-growing segment of their businesses, with computer, peripherals and telecommunications applications leading the way.

"Anytime you have a major transition phase in the interconnection industry, the independent contract people can flourish," says Harvey Miller, a Palo Alto, Calif., consultant. Adds Charles Henri-Mangin of Ceeris International, a Connecticut-based research firm: "The transition should last until the end of the decade. Even for the job shops that are just starting along the learning curve, there is a terrific opportunity. A lot of their customers want to eliminate their overhead but keep design and manufacturing close to home. The SMT phenomenon makes those factors that much more important."

Winston Chen, the president of Solectron Corp., a San Jose, California-based contract house with 1986 revenue of just under $60 million, believes SMT is his ticket to growth and profitability. Last year, SMT-related revenue was about $12 million, up from roughly $3 million in 1985. By the end of 1987, Solectron will have invested $6 million in surface mount hardware, software and training, with the aim of expanding from computers and peripherals to the medical instrumentation and telecommunications markets.

Shipments of PCBs by U.S. contract manufacturers*

(units)



Total 1986 shipments
22.6 million boards

*Based on a survey of the 50 largest U.S. contract assembly houses

Source: Gnostic Concepts Inc.

"It takes at least three years to perfect the SMT process," argues Chen. "The bare minimum entry fee is $1 million with a required investment of $3 million to $5 million to reach reasonable volume, plus the necessity of having substantial expertise in applied physics and chemistry. As a small or medium size OEM [original equipment manufacturer] wouldn't you rather utilize your limited assets in marketing and product development?"

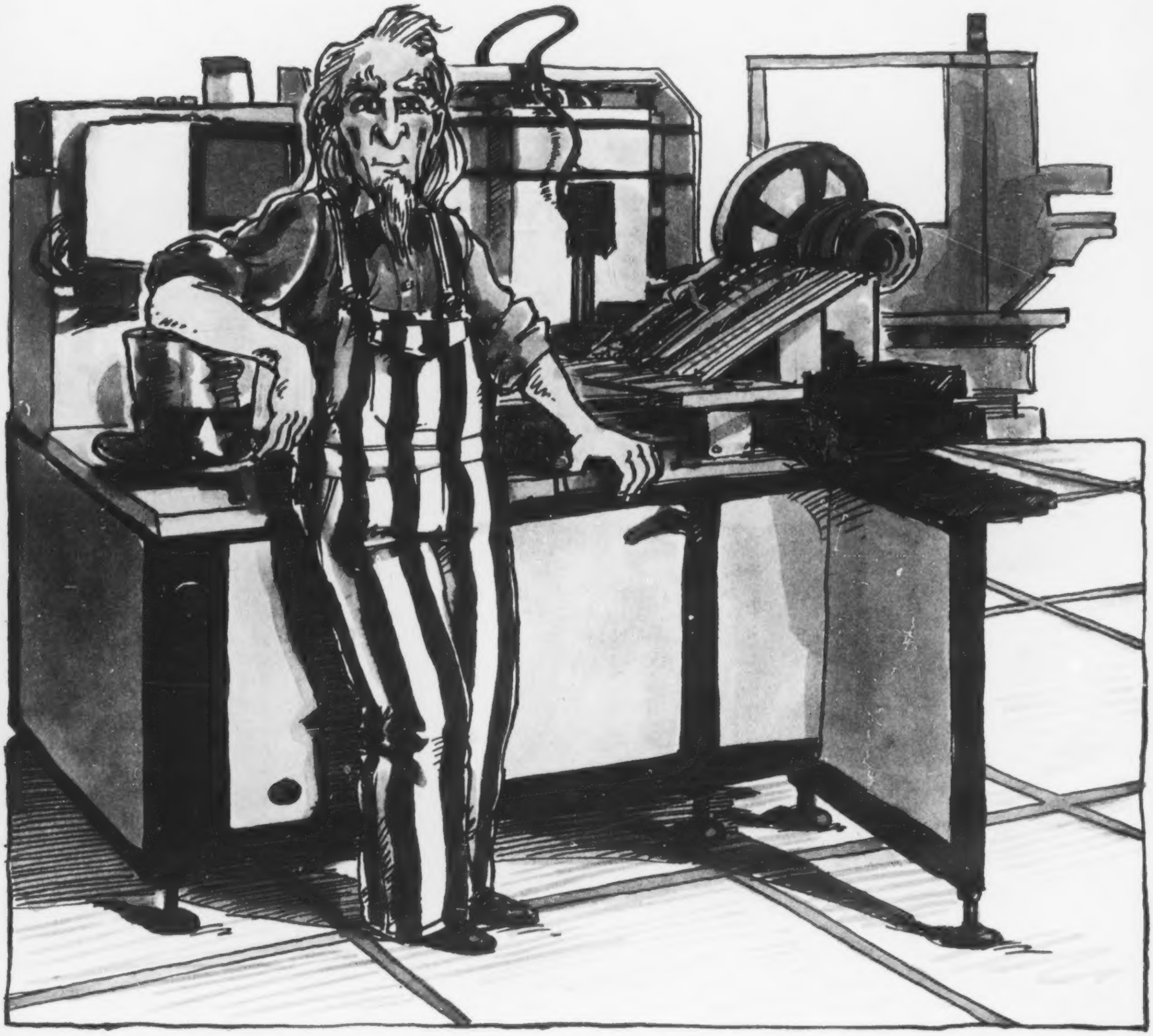
Chen acknowledges that some operations managers are reluctant to relinquish control over manufacturing to a contractor, but he insists most of his customers no longer have the luxury of a choice. "The electronics market is fluctuating more wildly than ever, and without assurance that you'll experience two years of steady growth, you need to look to a job shop for protection."

Cloning procedures

SCI Systems Inc., the largest U.S turnkey contract manufacturer, has made a big move to SMT at its main plant in Huntsville, Ala., and at its SCI Manufacturing group in Sunnyvale, Calif. The company claims it has the worldwide capacity to handle placement of 2.5 million surface mount parts a day. It is reportedly stuffing surface-mounted boards for IBM's soon to be introduced 286-based microcomputer, among other large contracts.

Walter Conroy, vice president and general manager of SCI Manufacturing, says that of the top 20 electronics companies, generating a total of some $150 billion in volume, SCI is working with at least 15 of them in surface mount. SCI Manufacturing consists of four recent acquisitions: Puosto Inc.'s Unitronic operation and AWI Inc., which are specialty SMT assemblers; Ouitest Inc., a board test company; and Nugraphix Inc., an SMT design center. "These acquisitions brought a lot of expertise [to SCI], particularly in design," says Conroy. "We've got 80 people here working in that area. The major problem we encounter in surface mount is poorly designed boards. Now we're able to look at that design and quote a price at manufacturing. We can get involved at the earliest stage right through to test."

Conroy adds that SCI's ability to "clone factories" in terms of processes and equipment makes it possible to



Jon McIntosh

design and prototype a board in the States and then assemble the board in volume at an SCI plant in Scotland or Singapore. This capability is essential in serving the disk drive industry, for example, because the industry has largely moved to the Far East. "Some people, like Maxtor or Seagate, will always go offshore for more labor-intensive electromechanical assembly. They need to be serviced locally."

ICI Array Technology, a San Jose design and assembly shop that was acquired a year ago by the giant Imperial Chemical Industries Plc. of Great Britain, has invested $3 million in SMT equipment and technology over the past three years. Today SMT represents about half of Array Technology's $16 million annual revenue. "We now understand issues like pad sizes [the surface-mounted part rests on a pad] and how much solder to dispense, and whether or not to use infrared or vapor phase soldering," explains vice president for marketing David Sear. "We know from looking at a board design whether it can be built with our process, without too much rework and touch-up. What this means is we have good feedback to manage our costs effectively."

SMT may be U.S. contract assembly houses' No. 1 weapon in battling offshore competition

Sear is among those trumpeting SMT as the No. 1 weapon in battling offshore competition. Resistors and other low-cost passive components currently make up the bulk of surface-mounted parts and thus Asian contractors have little leverage in component purchasing. Sear says that when ICs in small-outline packages and other surface mount configurations begin to proliferate, "I may look to set up an offshore purchasing office, but at this point when I look at the quotes we make against the offshore assemblers, we do pretty well."

"Disk and tape drives and other high-volume operations may go to overseas subcontractors," says Winston Chen of Solectron. "But in a customized, information-intensive business like SMT, where flexibility and quality are the keys, a well-managed domestic job shop has the advantage."

Inventory concerns

Still other U.S. contractors indicate that implementing just-in-time inventories can be a problem with offshore sourcing, as shipments can take up to

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two weeks by sea. In surface mount assembly, the problem is more severe, since the cost of inventory — both ICs and finished boards — is greater. Roger Main, president of Newark, New York-based IEC Electronics Corp., a $14 million contract house that has made a large investment in surface mounting, recalls one U.S. customer that ended up with tens of thousands of defective boards because of an overseas communications snafu. "With the complex layout and process requirements, you can't afford those kind of mistakes with SMT," Main concludes.

Those U.S. contractors eyeing overseas assembly say that they are only doing so for strategic reasons. Jim Hays, director for marketing of special programs at Avco Electronics Textron, with about $100 million in contract revenue (roughly $10 million in SMT), insists that "to be a world-class design-to-delivery company, you have to be a global competitor. The IBMs and Digital Equipments are worldwide, and we have to go where they go if we want to build products for them." Avco, which held off implementing SMT for nearly two years, 10 months ago installed its first surface mount assembly lines. Hays says that methodical approach allowed Avco to shake out a lot of the bugs that plagued its competitors. "We started slow and maybe we missed some of the front-page advertising hype that the others got," he says. "But we worked out a lot of problems in soldering and other processes, and I don't think we lost any business." Hays says Avco has booked about seven major surface mount contracts since last spring.

JIT inventories can be a problem with SMT offshore sourcing, as shipments can take up to two weeks

Even among those contract houses that are still sitting on the fence, there is a belief that, eventually, they will have to make the investment in SMT. Thomas Marcellas, vice president for research and development at the Rexnord Automation Electronic Operations Group in Hunt Valley, Md., insists that he is not "disappointed we didn't make the move earlier. We've done some training among our people, and we're a little smarter than we were two years ago, but we're in no hurry." Marcellas also says that the $22 million a year contract operation remains concerned with the lack of standards on package size and shape. Moreover, there are few standards on the proper mounting of those packages (for example, how much movement can be tolerated on the pad). "I'm more convinced now that we need to get started," says Marcellas, "but at $500,000 just for a prototyping capability, I'd like to see more of these issues solved."

As for the tiny specialty SMT shops that have sprung up since 1983, they continue to believe they can do any small job better than their larger counterparts. Henry Flajole, president of Advanced Surface Mount Devices Inc., says that his $2 million San Diego assembly house "does jobs the bigger companies can't do. This is a business for specialists and we have a four-year foundation in surface mount. There are no standards, no handbooks. You have to be very selective about the equipment you use. It's all trial and error. The bigger companies aren't doing the job very well."

Indeed, one contract assembler conceded that his first-pass yields on type 2 boards — which feature both surface mount and through-hole components — were running close to 80%, compared with 99% for all through-hole digital boards. He attributed the lower yields to poor accuracy of U.S.-made pick-and-place gear and "100 other process problems. We've got to get our yields to at least 90% on the first pass," he says.

However, when these sticky process problems are finally solved and gate arrays and other semicustom ICs in reliable SMT packages are plentiful, large customers that formerly relied on contract houses for high-volume production will begin bringing their SMT operations in house. Already the seeds are planted — IBM is said to have about two dozen SMT pick-and-place machines in Austin, Texas, and others such as AT&T (said to have about 20 high-speed placement machines) and General Motors are spending tens of millions of dollars on SMT for strategic purposes. Contract houses, of course, will still fill an ongoing need for prototyping services and for second sources to handle overflow, but, as analyst Harvey Miller says, "Once the product matures, generally the role of the contractor diminishes. Still, there's a pretty nice window over the next few years."

MARK MEHLER

Jockeying for position in low-cost logic analyzers

The low end of the logic analyzer market is only worth $40 million worldwide. But it's attracting some big names

At the low end of the logic analyzer market — worth about $40 million worldwide — instrument giants Gould Inc. and Tektronix Inc. are stepping up their efforts to establish a beachhead against Japanese competitors, including Matsushita's Panasonic Industrial Co.

Sales of all logic analyzers should reach $295 million this year, according to San Jose, Calif., market research firm Prime Data Inc. Although that is only a small portion of the $7 billion instrumentation market, it is the fastest growing segment, says Prime Data president Galen Wampler. He forecasts a 16% growth rate to the end of the decade. At the low end, where systems are often portable and cost under $8,000, that rate is 20%.

Technicians and engineers use logic analyzers to test and debug digital equipment, mainly microprocessor-based boards and controllers. They analyze the logic state or the timing of data channels inside the system at various stages of product life ranging from design and prototype to software integration and service.

Right now, the low end is dominated by tiny Arium Corp. of Anaheim, Calif. Arium, a privately held company, is responsible for 15% of all the logic analyzers sold, claims vice president David Blakemore, yet makes only 2% of the market's dollar sales. Monster instrument companies like Gould, Hewlett-Packard Co. and Tektronix are entering Arium's domain not necessarily to make money, Blakemore says, but "so they can offer a, quote, broad product line."

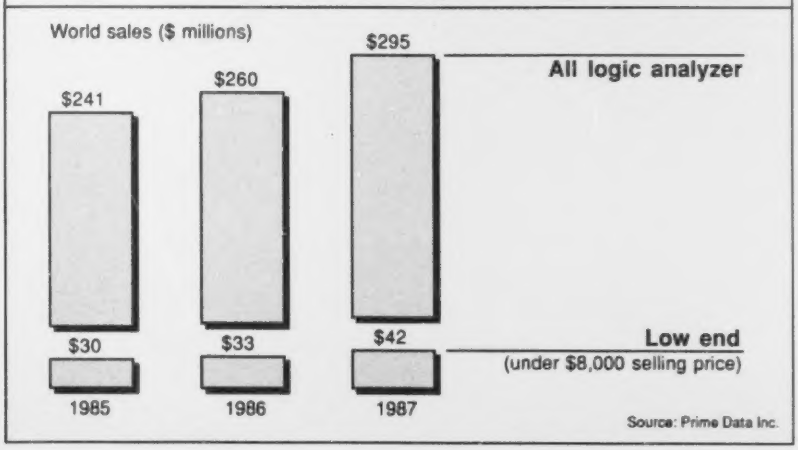
Charles Wiley, marketing operations manager for logic analyzers at Tektronix, the company Prime Data says owns the high end, puts it more bluntly. He admits that customers of Tek's midrange 1200 series analyzer "wanted one on each desk and had gone to our competitors" for less expensive models.

"We'd like to establish enough presence in the low end so that there is little or no reason for anybody else to try and get in," Wiley says. The "anybody else" in question is Japanese competition. "In a sense, we're taking the battle to their turf for a change."

Buying in

Tek took the first step of the battle by buying an Arium competitor, Breeze Test Instruments Inc. of Broomfield, Colo. Tek bought Breeze right out from under Gould, as Gould was reselling Breeze products under its own label. Gould is retaliating by building its own low-end logic analyzer that should be out this month, according to John Adam, marketing vice president of Gould's Design and Test Systems division in Cupertino, Calif.

Logic analyzer sales perk right along



Source: Prime Data Inc.

Gould sold some 600 of its K20 and K40 low-end analyzers in the United States last year, Adam says, but admits that the low-priced models squeeze his margins. Arium's Blakemore says big companies that sell direct cannot afford the sales. "They can't make a sales call for $3,000," he says.

Tek bought rather than built its model because, Wiley says, Tek was previously unsuccessful trying to "hack down" a higher performance model. Tek will reposition its current low-cost model — manufactured through its joint-venture with Sony Corp. — as a ruggedized portable for the service market. Wiley also says direct sales may be too costly for the low-end market. "The key is to get other sales channels," he says.

Eastern entries

Analyst Wampler estimates that 16% of the world's logic analyzers are sold in Japan, but that they are mostly sold by Tek and Hewlett-Packard. In contrast, only 10% of all oscilloscopes are sold in Japan, but nearly all Japanese instrument companies sell scopes. He says the software-intensive logic analyzers have not attracted the Japanese instrument makers so far, but that may change.

Panasonic, for one, has stuck with its expertise in signal generators and digital scopes, says Frank Orrow, manager of Panasonic's Instrumentation Department in Secaucus, N.J. In Japan, Panasonic (a subsidiary of electronics giant Matsushita Electric Industrial Co.) builds logic analyzers only for its largest customers. Nippon Telegraph and Telephone Corp., for example, buys hundreds and distributes them across Japan, he says.

In the United States' low-end market, Panasonic sold under $2 million worth of its VP-3621P last year, Orrow says, but it was a profitable business. Panasonic "would have dropped the line if it were horrible," he says. He had to raise prices because of the strengthening of the yen versus the dollar.

Still, one reason Panasonic is sticking it out is that the low end is attractive in these times of tight equipment budgets. "Everybody is short on cash these days and is saying, 'Let's stick to what we can afford,'" Orrow says. Frugal buyers are even purchasing demonstration units, he adds.

A force in the Japanese microprocessor development systems (MDS) market, Sophia Computer Systems Inc. is now in the logic analyzer business as well. Sophia is reselling the complete analyzer line of Dolch Logic Instruments GmbH. Dolch, in turn, is selling Sophia's MDSes in Europe, after shutting down its U.S. manufacturing and sales efforts.

"A lot of the strength of the analyzer market is in the low end," says Ken Pine, Sophia's sales and marketing vice president out of Santa Clara, Calif. He maintains Dolch had been doing well in the low end. Although he admits the 40C50 analyzer "is not a cash-thrower right now," he hopes to sell $3 million worth this year.

Sophia also sells its own Japan-built logic analyzer, but it is "rather simple" in technology, Pine concedes. He says Sophia considers itself more a trading company than a manufacturer. The addition of logic analyzers broadens Sophia's product line and adds revenue "to support our field crew," Pine says. Arium started to sell its own MDS last year.

Panasonic expects a shakeout in the rapidly crowding business. "In three to five years there will only be a few people in the market," Orrow says. To add to the crowd, Hewlett-Packard should be entering the low end soon from its strong position in the mid-range, the contestants agree. HP says it does not talk about unannounced products.

"If it has HP's name on it, it will sell," says Arium's Blakemore. He also thinks Tek has proven itself adept at inexpensive instruments, citing Tek's recapturing of the low-end oscilloscope market from Japanese competitors five years ago. Blakemore hopes he has enough of a lead on the big guys, with volume sales to Hughes Aircraft Co. and Unisys Corp. Also, N.V. Philips Gloeilampenfabrieken sells Arium analyzers in Europe.

Right now though, most of the business is in small sales. One such small sale was at Applied Automation Research Corp., a builder of custom process controllers. Applied Automation's president, Peter Lenan, says analyzers from HP and Tek were too expensive and too hard to learn for his taste. "They must have had a ton of venture capital," Lenans says of Arium, "The amount of engineering that went into it is unreal." Blakemore can smile at such praise — Arium has no outside investors.

DAVID CARD

Can Fairchild find smooth sailing for the Clipper?

Fairchild's new 32-bit chip has been slow to gain industry acceptance. So far, it has signed up a half dozen vendors

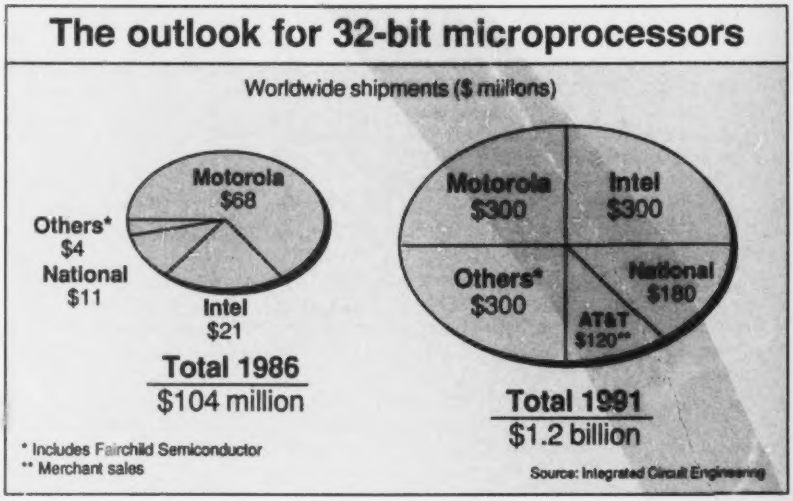
After spending tens of millions of dollars and four years of development time, Fairchild Semiconductor Corp. shipped the first of its 32-bit microprocessor chips, known as Clipper, in early 1986. But despite superior performance and Unix availability, demand for Fairchild's 5 MIPS (millions of instructions per second) Clipper is still slow.

Rival Intel Corp., for example, began delivering its much-touted 80386 at the end of last year, only several months behind schedule. Yet, at the start of 1987, Intel's customer list for the admittedly less powerful 32-bit chip read like a who's who in high tech, including COMPAQ Computer Corp., Convergent Technologies Inc., Gold Hill Computers Inc., Sun Microsystems Inc. and Televideo Systems Inc. Fairchild, meanwhile, had signed up only one major or original equipment manufacturer (OEM) — computer-aided design (CAD) vendor Intergraph — and a handful of smaller ones — Logic Replacement Technology Ltd. (LRT), Opus Systems, Specs and Zaiaz International — to incorporate Clipper into their products.

Clipper has also failed to make significant inroads into Motorola Inc. 68020 or National Semiconductor Corp. 32032 territory. "I don't expect Clipper to have much of an impact on the next generation of microprocessors [such as the Intel 80486 and Motorola 68030)] either," says Patricia Galligan, a research analyst with Dataquest Inc. of San Jose, Calif. Of the 478,000 32-bit microprocessors shipped worldwide last year, Clipper and a handful of others together accounted for less than 6% of those shipments, Galligan claims, while No. 1 vendor Motorola amassed 47% of the 1986 shipments.

Why has Clipper been slow to gain industry acceptance? It certainly is not software. Fairchild is probably ahead of most other chip makers in encouraging companies to develop versions of their applications software which will fully use Clipper's speed and other advanced capabilities. Besides, like all of the top 32-bit chip makers, Clipper's base operating sys-

FAIRCHILD's SACHS claims that the Clipper has the highest performance of any microprocessor on the market



The outlook for 32-bit microprocessors

Worldwide shipments ($ millions)

* Includes Fairchild Semiconductor
** Merchant sales

Source: Integrated Circuit Engineering

tem is a spin-off of Unix V, Version 3.0 — the latest and greatest release from Unix-developer AT&T. As a result, Clipper can run most of the rapidly growing base of existing Unix programs. Clipper customer Opus, for one, a vendor of IBM AT-based "personal mainframes," reports almost no difficulty in adapting software written for its National 32032-based products to its new Fairchild-based line.

"We have the highest performance microprocessor on the market today. It dissipates the least amount of power, takes up the smallest amount of space, and, from a price/performance view, is the least expensive," crows Howard Sachs, vice president and general manager for Fairchild's Advanced Microprocessor Division, the group in charge of Clipper, which is based in Palo Alto, Calif.

The club

However, the price of Clipper — $1,200 to $1,800 apiece, depending on quantity, or three or four times the average price of other 32-bit microprocessors — is not much of a factor in the chip's failure to win key designs. Also, analysts say, the established Motorola/Intel/National club is a tough one to crash, even though software compatibility across processors is less of a problem these days — thanks to Unix. Nonetheless, hardware and software design differences between new chips like Clipper and the 80386, 68020 and 32032 quickly become magnified in engineers' minds, analysts say.

"Clipper is an excellent device providing many solutions for many applications," says Dean Winkelmann, a research analyst with the Scottsdale, Ariz., market research firm Integrated Circuit Engineering (ICE). "But it is a distinctively different product — different to the point where it will be received by some people with skepticism and others with inexperience."

Besides, "the faster your product, the narrower your market becomes," says Winkelmann. "In the middle ground [where other 32-bit microprocessors end, and superminicomputers begin, in terms of price/performance] it's anybody's guess how big that niche will be. People are ready for the product, but it's a question of who will need it."

But Clipper's customers are betting that a lot of people are more than ready for the chip's super-advanced technology. Specs, a Munich-based vendor of VME boards; and LRT, another VME-board vendor based in Reading, England, are only the most recent converts.

Clipper "is opening a new page in the computing book," quips John Dodd, marketing manager for Huntsville, Alabama's Zaiaz, a vendor of advanced graphics boards for the IBM PC-AT, and one of the earliest Clipper devotees. "The introduction of Clipper is equal in importance to IBM's introduction of the PC." As opposed to other users of workstation and personal computer products that do not care whose chip is powering a system "our customers are very brand-conscious with this new generation of chips," Dodd says. "I attribute this to the fact that Clipper represents such a leap in power."

"Our customers know about Clipper," concurs Roland Schmidt, system product manager for Cupertino, California's Opus. "They're buying power and performance." Customers in the markets that Opus is targeting with its new top-of-the-line desktop workstation — large design simulation, finite element analysis and modeling, and nonturnkey CAD — "have an insatiable appetite for MIPS," Schmidt explains. "They want to do the kinds of things people do through time-sharing on a Cray [supercomputer]." Other 32-bit microprocessors just are not up to these tasks, he says.

Fujitsu in the wings

Another "customer" reported to be extremely interested in Clipper is Fujitsu Inc., which at press time was awaiting Justice Department approval of a plan to buy 80% of Fairchild Semiconductor from current parent Schlumberger Ltd. "One of the top reasons Fujitsu is looking at Fairchild may be the Clipper chip," claims ICE analyst Winkelmann. Fujitsu is in the process of designing, in conjunction with Hitachi, a 32-bit chip which reportedly will run Japan's alternative to Unix, TRON (the Tokyo Real-Time Operating System Nucleus). But that chip "addresses a different marketplace," says Fairchild's Sachs. "I don't foresee it being a source of any immediate competition or conflict."

Because of Justice Department regulations, Sachs refused any further comments on Fujitsu's current or future interest in Clipper. The company will also not talk about widespread speculation that the government may try to block the sale of Fairchild, an important military contractor.

As far as Fairchild's own future plans for Clipper, Sachs says that the chip's architecture is just at the start of its life cycle. Within five years, performance could expand from 5 MIPS to 50 MIPS, he claims. And Fairchild's recent announcement that it plans to move Clipper through the distributor channel, in addition to its direct salesforce, could also give the product a sales boost. But this will only happen, as long as rival chip makers, angry over the intended merger with Fujitsu, do not succeed in pressuring distributors not to accept any Fairchild/Fujitsu products.

But even Sachs is realistic about how much market share Clipper can expect to gain, even under the best circumstances. "Microprocessor choices are not made just on performance. They're also made on future products, existing software bases, etc. Clipper might mean a total redesign for some companies." And most are understandably unwilling to undertake such a venture, he admits.

MARY JO FOLEY

A market emerges for modem-based networks

Modem-based network management systems are a promising niche in the network control market

Network management is the communications buzzword of 1987. Every end user wants it and most communications equipment vendors claim to have it. But in a market that seems to have as many segments as players, a number of modem manufacturers have succeeded in developing a clearly defined niche within the network management arena.

The demand for modem-based network management systems — which collect test data from intelligent, microprocessor-based modems or multiplexors and display the results — is expected to grow to $137.4 million by 1990, from $104.5 million in 1986, according to Dataquest Inc., the San Jose, Calif., market research firm.

Fueling the growth of this niche, as well as the overall network management market, is the proliferation of increasingly complex private networks. According to research firm International Resource Development Inc., in Norwalk, Conn., the market for private network equipment and services, valued at $7 billion in 1985, will climb to $40 billion by 1995. This includes mammoth systems, as well as smaller modem-based operations. Electronic Data Systems Corp., the General Motors Corp. communications subsidiary, for example, has already invested some $500 million in a digital infrastructure of switches, trunks and terminals to service the needs of its parent corporation.

A survey of network management installations at more than 250 *Fortune* 1000 companies conducted by The Market Information Center reveals that today, the network management portion of communications budgets averages only 9%. That number, however, is expected to reach some 15% to 20% by the early 1990s, according to the Marlborough, Mass., research and consulting firm. More than half of the sites surveyed did not have any type of network management — 8% are in the process of evaluating systems and 43% have not yet started to investigate the implementation of any network management systems.

Of those that do have some sort of management system in place, 42% have installed modem-based management systems from the following vendors: Codex Corp., a division of Motorola Inc.; General DataComm Inc. (GDC), Paradyne Corp. and Racal-Milgo Inc., a division of Racal Electronics Ltd. Part of what makes these vendors so successful in such a fragmented marketplace is that they offer a systems, rather than a piecemeal, approach to network management and control. Up until just a few years ago, the trend in network management was based primarily on standalone diagnostic equipment that would test only minute portions of the network. Currently, however, "there is a move away from pure technology products to a whole systems approach," says Barry Gilbert, executive vice president of The Market Information Center.

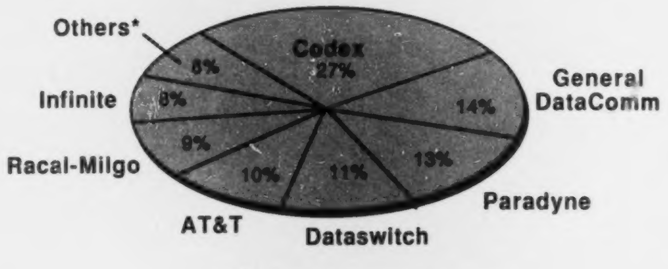
At all levels of network management, ease of use and flexibility are musts, says William Victoria, product line manager at GDC's Network Management Systems Division, based in Middlebury, Conn. Prices for systems that manage data communications

The U.S. market for data network control systems

	($ millions)		Compounded annual growth rate
Categories	**1986**	**1990**	
Third-party network management services	$192.0	$ 488.0	+23.6%
Protocol analyzers analog & digital	155.5	125.9	-5.1%
Network switches	165.0	170.2	+0.08%
Modem-based network management systems	104.5	137.4	+7.1%
Other	136.9	231.9	—
Total	**753.9**	**$1,113.4**	**10.3%**

Source: Dataquest Inc.

Modem-based network management systems market



Total 1986 shipments

Approximately 775 systems

*Including Digilog and Dynatech

Source: International Data Corp.

highways can start at the $20,000 range and go beyond $350,000. After such a hefty investment, Victoria says, customers want relatively inexpensive options if they need to change or upgrade their systems. GDC bases its management systems on a Unix core, but because of the software involved, a customer could also use an IBM PC AT, or a DEC VAX or PDP, at the central controls of the network, according to Victoria. "The key," he emphasizes, "is not to become hardware bound."

For personal computer-based management systems, either IBM PCs or IBM-compatibles with good graphics capabilities, are in vogue. And the Digital Equipment Corp. VAX series is the most popular minicomputer, according to Kathryn Korostoff, a research analyst at International Data Corp. (IDC) in Framingham, Mass. Of the approximately 775 modem-based systems sold last year, IDC says the majority were sold with terminals, about one-third with PCs, and no more than one-fourth with VAXs.

Because of the expense of systems and the quickening pace of technology, renting rather than purchasing equipment has become another customer option. Racal-Milgo, for example, now leases the majority of its systems, says Richard Courtney, marketing manager for network control systems at Racal-Milgo. The basic cost of a Racal-Milgo network management system can run between $10,000 and $60,000. Because network management is changing so rapidly, Courtney suggests, customers "have to take a hard look as to whether to buy or rent."

Services for sale

There is also a lucrative market emerging for third-party network management services. This segment, valued at $192 million last year, is forecast to reach $448 million by 1990, reflecting a 24% compounded annual growth rate, according to Dataquest. More than one modem management systems vendor is looking for additional revenue opportunities in this arena.

Largo, Florida-based Paradyne entered the third-party network services market last September with its announcement of NetCare Services — which provides both on-site and remote management services. According to Richard P. Checket, director of NetCare Services, Paradyne views this arena as "becoming a major portion of our business." Paradyne currently has customers in six states.

Today there is a move away from pure technology products to a systems approach

This past January, Codex began offering its ONLINE Remote Network Monitoring Service. Although the original business plan forecasted that small- to medium-sized businesses would be the ones most ready for this type of service, a surprisingly large number of *Fortune* 500-sized potential customers are expressing interest in ONLINE, says Paul LaRiviere, director of the Advanced Implementations Group at Codex's customer services division in Mansfield, Mass.

CAROL SUBY

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Where's the juice in U.S. power supplies?

With excess capacity and slow growth, power supply makers are shrinking designs and rethinking their strategies

By Bruce C.P. Rayner

With the elusive electronics recovery still just around the corner, the prognosis for the $5 billion U.S. power supply industry is for another flat year in 1987 with expectations of better health in 1988. Because the market is fragmented, strategies for survival differ. But the emphasis by many U.S. companies is on broadening product lines, reducing manufacturing costs and entering new markets.

Domestic consumption of power supplies is forecast to grow a meager 8% to $5.3 billion this year, up from $4.9 billion in 1986, forecasts Mohan Mankikar, president of Micro-Tech Consultants (MTC), a San Francisco-based market research firm specializing in the power supply industry. With too much excess capacity and over 400 companies vying for a piece of the action, it will take business acumen and a fierce competitive drive to increase market share.

A switch to converters?

Power supplies provide the direct current that electronic circuits need to operate at a constant, regulated voltage. There are three main types of supplies: alternating current to direct current (AC/DC) with linear regulation, AC/DC with switching regulation, and DC/DC converters. Switching power supplies, or switchers — which make up almost 50% of U.S. consumption — will continue to capture the lion's share of the market, says Mankikar, growing to over 60% of total U.S. consumption by 1989.

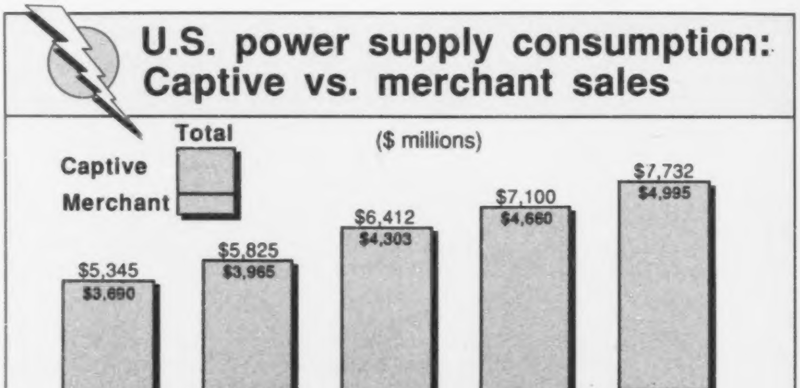
Switchers wrestled away market leadership from linear supplies in the early 1980s as a result of the growth in the personal computer market. (Switchers can be smaller than linears of the same power rating because linears dissipate excess energy as heat, whereas switchers regulate the output voltage by switching the input on and off at high frequency.) Mankikar believes switchers will continue to enjoy the best growth potential, but expects DC/DC converters — units that take raw DC power and convert it to regulated power — to begin to gain a "higher profile" in 1987. He pegs the U.S. consumption of converters at $735 million for 1986 and expects it to grow to $1.16 billion by 1991.

Others disagree that converters, used predominantly in telecommunications equipment, will see much activity unless demand improves significantly. With telecommunications growth forecast at around 12% for 1987, Mankikar's converter expectations might prove overly optimistic, some pundits say.

But one relative newcomer in the DC/DC converter game, Vicor Inc. of Andover, Mass., is counting on converters, not only to grow, but, to radically change the power supply market in the next five years. In the future, says Vicor president Patrizio Vinciarelli, the power supply industry will be more like the semiconductor industry, demanding heavy capital investment and technology, and leaving only a few companies in positions of market leadership. This industry is about to undergo a "fairly major revolution," he predicts.

Whether or not Vinciarelli is correct will depend on more than technology. Above all, says Bruce Hamilton, vice president for marketing at ACDC Electronics, an Oceanside, California-based division of Emerson Electric Co. that makes a broad line of custom and standard supplies, the demand for power supplies follow ship-

U.S. power supply consumption: Captive vs. merchant sales



Source: Micro-Tech Consultants

ments of electronic components. Some forecasters expect component shipments to increase steeply by the end of the year, but, Hamilton says, "I'm not so optimistic as that."

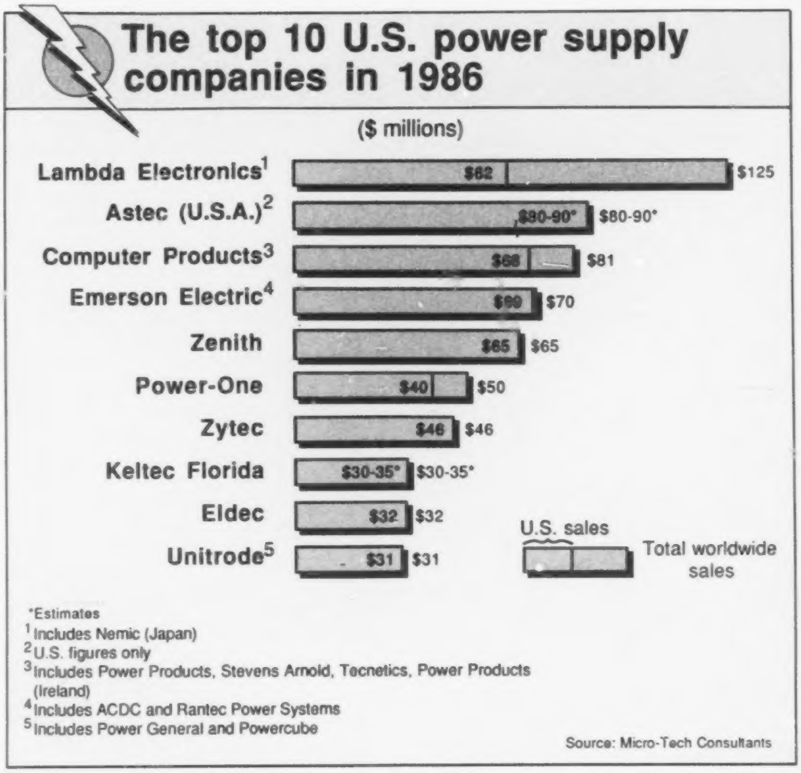
Both the merchant and the custom market for power supplies depend on demand from original equipment manufacturers (OEMs) in the computer, telecommunications, and industrial electronics equipment industry. None of these OEM markets seem poised for much growth as equipment inventories remain high. Partly because of these excessive inventory levels, 1987 orders for power supplies are expected to grow at a slower rate than OEM production.

Powerful strategies

With not much overall growth expected, some of the top makers have been targeting market segments and buying into them to expand their market share. First-placed Lambda Electronics, a division of Veeco Instruments Inc., bought Magnapower Inc. in December of last year to gain entry into the military market. Previously, No. 2-ranked Computer Products Inc. (CPI) had purchased Boschert Inc., of Milpitas, Calif., a leading maker of switching supplies.

CPI president Edward Schneider does not expect the market for power supplies to recover significantly this year, but he sees his company's position strengthened by the acquisition. He says the Pompano Beach, Fla., company, which makes both custom and standard supplies at four domestic and three offshore divisions, now has a more powerful sales and distribution network. Schneider believes that the only successful way to address all markets is through multiple companies, "where you are able to market and distribute [supplies] through a single, very knowledgeable and powerful organization."

Joshua Hauser, executive vice president at Veeco's Lambda Group, says Lambda's strategy in the past has been to grow internally to meet the market demand with standard products of proprietary design. Almost 70% of the division's business is in switchers and DC/DC converters. (Mankikar estimates that Lambda sold $125 million worth of power supplies worldwide last year.) But Lambda's acquisition of Magnapower to enter the custom military market represents a break with tradition. "We look to acquisition as another way of expanding both product and market position," says Hauser.



The top 10 U.S. power supply companies in 1986

*Estimates
[1] Includes Nemic (Japan)
[2] U.S. figures only
[3] Includes Power Products, Stevens Arnold, Tecnetics, Power Products (Ireland)
[4] Includes ACDC and Rantec Power Systems
[5] Includes Power General and Powercube

Source: Micro-Tech Consultants

With pricing pressure from customers intensifying, domestic manufacturers are also looking to establish more efficient operations. Far East suppliers are able to beat domestic prices in the low-power, high-volume custom business and are starting to branch into other segments of the market as well. The way the Far East manufacturers have done that, says CPI's Schneider, is "they've successfully captured some significant business from perhaps Apple and IBM."

Lambda's Hauser believes it is the high-volume, custom-design power supply companies, both foreign and domestic, that are responsible for the severe pressure on prices. If an eager manufacturer of custom supplies signs a large-volume contract at some ridiculously low price, he says, other customers come to expect the same prices, even if they do not carry the same clout as an IBM or an Apple. As a result, Hauser says, "I don't think anybody in the custom business is making any money, they're [only] absorbing overhead." That is not the worst of it, he laments. Price wars in the high-volume business tend to spill over from the custom to the standard business. As a result, adds Hauser, domestic power supply makers must trim their sails to be price competitive.

The pressures to keep costs down just to stay competitive are tremendous

Cutting manufacturing costs

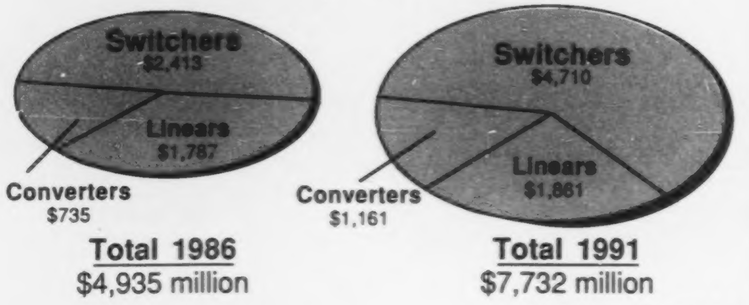
One way to cut costs is to set up shop overseas in order to take advantage of cheaper labor and proximity to new markets. Lambda has plants in Mexico (for the U.S. market); in Israel (for Europe); and in Japan and Singapore (for the Far East). CPI is in Hong Kong, Ireland and the West Indies; Astec USA (HK) Ltd. has plants in England, Hong Kong and Malaysia; and both ACDC and Zenith Electronics Corp. have plants in Mexico. Zenith is also in Ireland.

The pressures to keep costs down just to stay competitive are tremendous, says Edgar Baez, director of marketing for the components group at Zenith, a leading producer of custom switchers for the OEM personal computer market. The Glenview, Illinois-based company last year consolidated its power supply production in a 200,000-square-foot plant in Chihuahua, Mexico, that services the United States and the Far East. It also has a plant in Kells, Ireland that caters to the European market. Zenith's strategy is to design power supplies in the United States, then set up high volume production offshore, Baez says.

As for making onshore plants more

How the pie is sliced: U.S. consumption by segment

($ millions)



Source: Micro-Tech Consultants

efficient, a number of companies have adopted tighter inventory control and are automating manufacturing operations where it makes sense. ACDC's Hamilton says his company has gone to dedicated production lines and reduced inventory by adopting just-in-time (JIT) — getting components to the shop floor just in time for production. Also, comments Hamilton, "[We're] pressing our suppliers very hard to give us improved pricing."

To get component costs down, ACDC is negotiating annual purchase contracts to lower component costs. "That is a bit countercyclical to the industry," comments Hamilton, noting that many of his competitors are opting for shorter, not longer, agreements. "But to get [lower] costs," he says, "we've decided to take the risk, and it's paid off handsomely." ACDC also buys complete supplies offshore, he adds.

But Far East manufacturers can also cut costs. Astec USA, a subsidiary of BSR International Plc. of Britain, installed a computer manufacturing system two years ago in one of its Hong Kong facilities to monitor production capacity and efficiency. Astec has been "very successful" at keeping the manufacturing process under control, claims Earle Younger, marketing manager at Astec.

Tailored modules

"The key to success," says Barry Chenes, vice president for marketing at Chatsworth, California-based Powertec Inc., a division of Low & Bonar Plc. from Scotland, "is to provide customers with what they want." He claims he can do this in the custom market by modifying standard products — building standard supplies to a minimum of 80% completion and then modifying them to the customer's requirements. Modified-standard supplies accounted for 60% of Powertec's $26 million sales for 1986, says Chenes. This market is fairly safe from foreign competition, he adds, because orders are relatively small in size and the producer must work very closely with the customer.

Powertec is not alone in pursuing the modified-standard approach. Hamilton claims that ACDC's dedicated production lines and the adoption of JIT allows the company to provide "modified from stock" supplies: "If we didn't have those dedicated lines and we couldn't modify those core units from inventory, we couldn't meet those [customer's] requirements." The same approach that enables faster delivery also gives reduced costs because it reduces work-in-process (WIP) inventory, he adds.

Astec, which specializes in low-power, custom switchers, employs the modular approach in its higher power (500 to 1,500 watt) lines. By using new technology available at Astec, says marketing manager Younger, the modules allow for a standard front-end with a DC voltage rail to be tailored to the customer's needs. The modular approach allows Astec to speed up the turnaround time in full custom designed switchers, Younger says.

SMC for military supplies

Astec's power modules use some surface mount (SMCs) components — along with conventional through-hole components — to save space. But the cost of SMCs limit their commercial application. Hamilton of ACDC points out that the advantages of SMCs are not always evident because there is no getting around the use of bulky transformers, capacitors and inductors. "Most people won't pay for substandard sizes," he says, "and if you stay within a standard-size envelope, you can't command a premium."

But what cost constraints limit surface mount components in commercial supplies do not present a problem in the military market — a leader in the demand for miniaturization. "SM technology is advancing at the same rate as our customers' desire to have smaller, more compact and capable units," says Richard Behrens, vice president and general manager at the $32 million power conversion division of Eldec Corp., that caters to the aerospace industry.

With requirements for higher power density, Behrens says that Eldec's designers are expected to pack four watts per cubic inch. The commercial average is between one and three watts per cubic inch. The problems, notes Behrens, arise when customers want all of the extra goodies thrown in as well, like orderly start up and shutdown, and built-in test. "Nothing is getting easier," he laments.

Standard distribution

With the trend toward more standard products, makers are looking to industrial distribution as a vehicle to

U.S. switching power supply consumption by application*

	1984	1986	1989	1993
Computer	51%	50%	53%	58%
Communications	6%	6%	6%	5%
Government/military	15%	16%	15%	15%
Industrial	9%	9%	8%	6%
Business/retail	11%	11%	10%	7%
Consumer	1%	1%	0%	0%
Instrument	7%	8%	8%	8%

* Totals may not add up to 100% due to rounding

Source: Gnostic Concepts Inc.

increase market share. ACDC has signed with Time Electronics, which, together with Hamilton/Avnet, is part of Avnet Inc.'s Electronic Marketing Group; with Newark Electronics, a subsidiary of Premier Industrial Corp.; and with a number of regional distributors. Although distribution makes up only a small percentage of ACDC's sales, Hamilton says the company plans to increase its reliance on this channel. He reports good progress, for example, in distributor sales of the company's new low-power (40 watt to 220 watt) switching supplies line.

CPI's Schneider claims that the consolidation of the Boschert acquisition has given his company the strongest distribution network in the entire industry. This includes 141 North American distribution locations with the likes of Bell Industries, Schweber Electronics and Marshall Industries among others. With more than 180 distributor locations worldwide, Schneider expects CPI to outperform the market in 1987. Approximately 20% of CPI's 1986 U.S. sales and 25% of its worldwide sales were through distribution, a company spokesperson says.

But the largest manufacturer, Lambda Electronics, still believes in being its own distributor. The company has warehouses at three U.S. locations as well as in Canada, England, France, Germany, Israel, Japan and Singapore. The company has an online order entry system which, Hauser claims, allows it to deliver as quickly and efficiently as any distributor.

The trade-off between using independent distributors and in-house distribution is the cost of inventory, he explains. A customer pays either a distributor between 25% and 35% of cost, or pays the manufacturer a premium for the inventory carrying costs. After weighing these alternatives, Lambda has opted to maintain its own inventory. "If you don't have the inventory, your ability to service the customer is less," says Hauser. ☐

New technology from Vicor: Watts up, doc

Vicor Inc., an Andover, Mass., company that has patented direct current to direct current (DC/DC) converters, is one of a new breed of companies banking on new technology to succeed in the power supply market. Headed by a former Princeton University particle physicist, the 5-year-old company doubled its sales in 1986, from 1985, and expects to do the same in 1987. Power supply researcher Mohan Mankikar, president of Micro-Tech Consultants of San Francisco, estimates Vicor's 1986 sales at $7 million.

Patrizio Vinciarelli, president of Vicor, developed a technology for a high-frequency DC/DC converter that operates at one megahertz; 10 times faster than commercial switchers. Vicor's new converters, claims Vinciarelli, deliver 37 watts per cubic inch, more than 10 times the industry norm. Basically, there is an inverse relationship between switching frequency and a converter's size: the faster the switch, the smaller the unit.

The demand for DC/DC converters — units that convert raw DC power to rectified and regulated output voltage — is expected to increase at a compounded annual rate of 9.6% through to 1991, says Mankikar. But some types of converters, namely those that use the distributed architecture approach — placing converters directly on the circuit boards at the point of use — could outpace traditional converter demand. This calls for converters, like Vicor's, that can deliver enough power to satisfy the ever increasing number of functions and features incorporated in modern telecommunications equipment.

Vicor has two patents which have, so far, earned it over $4 million in royalties from four companies. Licensees include: Lorain Products, of Ohio, a maker of custom power supplies; Integran, a Japanese company that makes commercial units; Kollmorgen Inc., whose two facilities, Inland Motors in Arizona and Inland Power in Ennis, Ireland, supply the military and European markets respectively; and Westcor, a partially owned subsidiary of Vicor that is a second source for the domestic commercial market.

VICOR's VINCIARELLI: The power supply industry is about to undergo a "fairly major revolution"

Henry Hilliard/Picture Group

Westcor president, Allen Henderson, former director of marketing at Boschert Ltd., now a part of Computer Products Inc. (CPI), believes there is a good chance the Vicor products will become the de facto industry standard for DC/DC converters. MTC's Mankikar agrees that the potential is present. Vicor's Vinciarelli claims to have maintained that view for sometime now, "but we haven't told anyone on the outside world, except our investors," he says.

Mankikar ranks Stevens-Arnold Inc., the Boston-based DC/DC converter maker and subsidiary of CPI, as the market leader in dollar sales. But the majority of its products are under 50 watts. Vicor has targeted the 50-watt-and-above market and has managed to carve a very lucrative niche in a field with few competitors: a strategy Mankikar calls "very shrewd," adding that the company "has played its cards very well."

Vinciarelli claims that Vicor's products are not dependent on the growth in the electronics industry "because we can be very effective in displacing existing competitors." Applications for the converters range from the traditional telecommunications, computer, and industrial equipment markets to the brake system in the Japanese Bullet train and the communication system aboard Air Force One, the official plane of the president of the United States. ☐

The rise of Canadian electronics

Canada is the largest U.S. electronics market. But it's also becoming a major electronics exporter

By Tim Smart

In most respects, the Canadian electronics industry is a miniature version of its counterpart in the United States. U.S. firms like Control Data Corp., Litton Industries Inc., NCR Corp., Westinghouse Electric Co. and Xerox Corp. all have sizable operations in Canada. And two U.S.-owned electronics companies — IBM Canada Ltd. and Canadian General Electric, a division of General Electric Co. — had Canadian sales in 1986 of more than $1 billion each.

The U.S. sells more electronic products to Canada than any other country

But Canada is also populated with such homegrown standouts, most notably telecommunications giant Northern Telecom Ltd., the country's largest electronics company, and Spar Aerospace. And while the Canadian electronics industry may never rival the United States and Japan in international prominence, it remains a leading market for U.S. computer companies and an important source of highly sophisticated telecommunications and defense electronics equipment.

The importance of the United States as a market for Canadian electronics companies cannot be understated. Of $1.35 billion in computer and office equipment exported in 1985 (the last year for which full figures are available), $1.1 billion went to the United States. Similarly, of $849 million in electrical components exported, $732 million worth went across the border.

Also, the United States sells more electronic products to Canada than any other country. In 1985, the American Electronics Association says that Canada was the recipient of $4.9 billion in U.S. electronics exports — ahead of Britain ($3.6 billion) and Japan ($3.2 billion). Canadian electronics trade with the United States in 1985 was $2.6 billion, creating a trade surplus of $2.3 billion in favor of the United States.

Although not large by international standards, the Canadian electronics industry has nevertheless shown itself to be dynamic and competitive in world markets. "Electronics is not one of the leading industries in Canada," says Christopher Trump, vice president of Spar Aerospace Ltd., a $170.89 million (for fiscal year ending Dec. 31, 1986) Ottawa manufacturer of satellites and earth stations. Forestry, mining and automobiles are Canada's largest industries, notes Trump, but, he adds, "I think increasingly there is a recognition that more needs to be done."

Niche markets

Adds Roy Woodbridge, president of the Canadian Advanced Technology Association: "Part of the reason we lag the U.S. is really a culture and awareness problem. We still have a very strong [natural] resources-based mind-set in this country."

Nevertheless, Canadian electronics companies have carved out significant niches for themselves in several fast-growing areas of the worldwide electronics market — including telecommunications and defense-related hardware. "We're really small in consumer electronics," says Keith Munro, a specialist in U.S. trade for the Canadian government. "But telecommunications and aerospace are two industrial sectors where good things are happening."

"There's no question that our major areas of expertise are recognized worldwide," Woodbridge also notes. "But what isn't recognized is that that base of competence is fairly narrowly focused. We're going to have to rapidly diversify and broaden the base."

The semiconductor industry in Canada, for example, is very small by world standards and functions primarily as a captive supplier to the large telecommunications companies. And Canada also has about 50 printed circuit board companies, most of which produce for the export market. A third area of expertise is also very focused: the manufacture of process and inventory control systems for use in natural resource industries such as, pulp and paper and petrochemical refining.

One reason why the Canadian electronics industry has been slower to develop than its counterpart in the States is the absence of a large local market. More than three-quarters of all finished goods made in Canada are exported, and electronics goods are no exception. Canadian Marconi Co., a leading supplier of field radios to the Pentagon, did more than half of its $165.986 million (for fiscal year ending March 31, 1986) in sales with the United States. And Northern Telecom is a major provider of central office switching equipment to the regional Bell operating companies (RBOCs).

"About 60% of our business is in the U.S.," says Andrew McMahon, executive vice president for marketing at Northern Telecom. "We've grown very rapidly in the U.S. in the last 10 years, going from roughly zero sales to where we have significant market share."

In the hotly contested market for digital switches sold to telephone companies, Northern Telecom has between 45% and 50% of the market, according to McMahon. That puts it even or slightly ahead of archrival AT&T. In private branch exchange sales, Northern Telecom has a market share of more than 20%, again competitive with the $35 billion U.S. telecom giant.

In fact, discounting Montreal-based Bell Canada Enterprises Inc., which has a controlling ownership in Northern Telecom and is not primarily an electronics company, Northern Telecom is the largest electronics company in Canada with $3.257 billion in 1986 sales.

"We're, I think, a good example of what can be accomplished by a Canadian company," says McMahon. "I think it's widely recognized that Northern Telecom has done the things that are required to be successful in the Canadian and worldwide marketplace." One thing the company has concentrated on is research and development. Bell Northern Research, in which Northern Telecom holds a majority stake, is the premier research organization in Canada.

Few government handouts

"We do not depend on government handouts or grants for any of our research or development," McMahon says, trumpeting a widely held view that the Canadian government is far less supportive of its electronics industry than is Washington. Specifically, say McMahon and others, Canadian electronics companies lack the cushion afforded their U.S. counterparts by the Pentagon, which underwrites many programs dear to the heart of the U.S. electronics industry.

"There's a virtual lack of any military research being done," says Spar's Trump. Given that, it's a wonder that

Canadian electronics exports and imports

First three quarters ($ thousands)

	1985	1986	Change
Communication equipment			
Exports	$816,772	$710,865	-13.0%
Imports	$509,953	$649,484	+27.4%
Trade balance	$306,820	$61,381	-80.0%
Electronic components			
Exports	$671,738	$626,991	-6.7%
Imports	$1,102,376	$1,076,843	-2.3%
Trade balance	-$430,638	-$449,852	NM
Telephone apparatus equipment*			
Exports	$460,612	$376,851	-18.2%
Imports	$133,445	$145,696	+9.2%
Trade balance	$327,167	$231,155	-29.3%
Printed circuit boards			
Exports	$29,402	$31,928	+8.6%
Imports	$22,355	$25,691	+14.9%
Trade balance	$7,047	$6,237	-11.5%
Computers*			
Exports	$1,011,996	$988,157	-2.4%
Imports	$2,175,788	$2,245,470	+3.2%
Trade balance	-$1,163,791	-$1,257,314	NM
Integrated circuits and semiconductors*			
Exports	$451,058	$383,845	-14.9%
Imports	$692,451	$646,036	-6.7%
Trade balance	-$241,393	-$262,191	NM
Television sets			
Exports	$36,394	$29,903	-17.8%
Imports	$111,566	$139,845	+25.3%
Trade balance	-$75,172	-$109,942	NM
Radios			
Exports	$4,112	$3,123	-24.1%
Imports	$136,539	$130,203	-4.6%
Trade balance	-$132,427	-$127,080	NM
Combination radio/phonograph sets			
Exports	$72,286	$71,486	-1.1%
Imports	$167,943	$170,855	+1.7%
Trade balance	-$95,657	-$99,369	+3.9%
Geophysical and mineral prospection equipment*			
Exports	$20,112	$28,238	+40.4%
Imports	$115,636	$69,598	-39.8%
Trade balance	-$95,525	-$41,359	-131.0%
Commercial communication equipment			
Exports	$224,708	$239,303	+6.5%
Imports	$171,151	$223,704	+30.7%
Trade balance	$53,557	$15,599	-70.9%
Photocopy machines*			
Exports	—	—	—
Imports	$162,776	$196,272	+20.6%
Trade balance	-$162,776	-$196,272	NM

* Includes parts
NM = Not meaningful
Conversion rate: Canadian $0.743 = U.S. $1

Source: Government of Canada, Regional Industrial Expansion

Canadian firms are as successful in selling to the U.S. Department of Defense as they are, something that is partly explained by policies that Ottawa and Washington have set to ensure reciprocal trade in arms.

"There's a good trade in defense electronics," says Robert Craig, a commercial counselor at the Canadian Embassy in Washington. "We had [military] sales in 1985 to the U.S. of about $1.6 billion but they're going to be down a bit in 1986. I would say of that trade, about 25% or so is in electronics."

"There is an understanding and letters of agreement that we will kind of keep the defense trade in balance," Craig adds.

Even so, the Canadian defense electronics industry has nothing to be ashamed of. Canadian Marconi, for example, has more than half of the worldwide market for VHF/UHF tactical military radios, which are made in Montreal. Garrett Canada, with headquarters near Toronto, produces more than three-quarters of all the aircraft temperature control systems in use. Other successes include the Canadian subsidiary of Litton Industries, which builds inertial navigation systems for the cruise missile, and CAE Electronics Ltd., which supplies commercial jet flight simulators to U.S. airlines.

The Canadian defense electronics industry had sales of $3.8 billion in 1985 — $1.6 billion of which went to the Canadian armed services — and was projected to have increased that to $4.4 billion by the end of last year. The industry employs more than 40,000 people in Canada.

U.S. influence

Much of the electronics business in Canada is conducted by wholly owned subsidiaries of U.S. firms, which have extensive sales and manufacturing activities north of the border. IBM Canada and GE combined, for instance, did more than $2.2 billion in sales last year and the Canadian subsidiaries of Digital Equipment Corp., Westinghouse and Xerox each had more than $372 million in sales.

The heavy amount of foreign investment in Canada's electronics industry is evident in that the leading companies are either owned outright by U.S. or British companies or their shares are widely traded on the New York, Toronto and Tokyo stock exchanges. But the subsidiary relationships go both ways. Northern Telecom and Mitel Corp., two of Canada's leading telecommunications firms, both have United States-based subsidiary operations.

The presence of a huge market across the border and the high percentage of U.S. firms in the industry has led some to doubt whether Canada can develop that large of an electronics industry of its own. Says Trump of Spar Aerospace, "We can compete successfully with some very large players and that is the kind of mind-set we need to develop more of in Canada. For too long, there's been

Top Canadian electronics companies

Company	Canadian revenue ($ thousands)	Canadian electronics revenue ($ thousands)	Canadian employees	Canadian revenue per Canadian employee
Northern Telecom	$3,257,014.8	$3,257,014.8	46,624	$69,857
IBM Canada	2,338,964.0	2,338,964.0	11,000	212,633
Canadian General Electric	1,109,819.1	NA	11,605	NA
Xerox Canada	642,620.7	285,295.7	4,200	67,928
Westinghouse Canada	530,962.7	NA	5,400	NA
Digital Equipment of Canada	466,898.7	466,898.7	2,598	179,715
3M Canada	319,490.0	31,949.0	2,000	159,745
Mitel	302,428.7	302,428.7	4,655	64,969
Rogers Communications	302,096.8	302,096.8	3,350	90,178
ITT Canada	289,027.0	NA	5,000	57,805
Honeywell [1]	284,790.4	284,790.4	3,781	75,321
The Philips Group	266,977.0	18,906.8	1,830	10,332
CAE Industries	243,704.0	110,239.2	4,800	22,967
Sperry [3]	231,816.0	231,816.0	NA	NA
Litton Systems Canada	227,052.0	227,052.0	3,300	68,804
Matsushita Electric of Canada [2]	222,900.0	222,900.0	NA	NA
Control Data Canada	215,406.6	215,406.6	1,800	119,670
Hewlett-Packard (Canada)	209,633.0	209,633.0	1,136	184,536
Burroughs [3]	167,175.0	167,175.0	NA	NA
Canadian Marconi	165,986.1	154,279.2	2,400	64,283
NCR Canada	155,400.0	139,860.0	2,050	68,224

[1] Company estimate
[2] ELECTRONIC BUSINESS estimate
[3] Now Unisys Corp., formed by the merger of Burroughs and Sperry in September 1986; Canadian merger effective January 1987

kind of a 'branch plant' mentality here."

Martin Robichard, a trade officer in the Canadian consul's office in Boston, says Canadian firms have not been aggressive marketers of their country's products. "They have the European style of laid-back marketing," Robichard says.

One immediate problem for Canadian exports to the United States could be the weak dollar, which is making goods produced in other countries more expensive for U.S. customers. Jeanette Garrety, a Bank of America economist and specialist in the electronics industry, says that during the next decade U.S. companies will see their exports increase 50%. Presumably this would be at the expense of exports to the United States, but Garrety says it is uncertain what effect this will have on Canada, where the dollar-to-dollar relationship has not changed that much.

"The U.S. dollar has not fallen as dramatically against the Canadian dollar as it has against the Japanese yen or the German mark," Garrety says. There is also the question of the overall trade relationship with Canada during this time of pro-protectionist feelings in the U.S. Congress.

The industry in Canada is supported by a network of universities, investment banks, venture capitalists and trade organizations. More than 100 companies belong to the Canadian Advanced Technology Association, which assists in the promotion of Canadian-owned technology companies. Membership is across a broad spectrum, though many are small, closely held ventures. The membership rolls do include such Canadian electronics industry giants as Electrohome Ltd., makers of video display equipment, and Mitel Corp.

"They're research-intensive companies," says Woodbridge of the Advanced Technology Association. "The members are primarily from information technology fields but we have branched out far beyond that to biotechnology and advanced materials."

In doing so, the association reflects the unique nature of the Canadian economy. Unlike the United States, where start-ups are often clustered around technologies spawned by the electronics industry — like personal computers and video equipment, many of the newer Canadian firms are allied to the bedrock natural resource-based industries. HSA Reactors Ltd., a Rexdale, Ontario company, for instance, makes computer-based systems used in the recovery of mined metals. Mechron Energy Ltd. manufactures electric power systems for use in harsh environments. More than 75% of all electronic equipment used to detect minerals is manufactured in Canada.

Of the venture capital industry in Canada, Woodbridge says: "It's not quite as vigorous as it is in the U.S. We have lagged in comparison, particularly with regard to investment in start-ups, but it is extremely active and growing." □

Parent company	Parent company revenue ($ thousands)	Total employees	Overall revenue per employee	Canadian revenue as a percent of parent company revenue	Canadian electronics revenue as a percent of total Canadian revenue	Fiscal year end
Bell Canada Enterprises	$13,932,500.0	109,592	$127,131	23.4%	100.0%	12/31/86
IBM	51,250,000.0	403,500	127,014	4.6%	100.0%	12/31/86
General Electric	35,210,000.0	359,000	98,078	3.2%	NA	12/31/86
Xerox	12,900,000.0	100,367	128,528	5.0%	44.4%	12/31/86
Westinghouse Electric	10,731,000.0	115,000	93,313	4.9%	NA	12/31/86
DEC	7,590,357.0	94,700	80,152	6.2%	100.0%	6/28/86
3M	8,602,000.0	33,800	254,497	3.7%	10.0%	12/31/86
British Telecommunications	8,387,000.0	NA	NA	3.6%	100.0%	3/28/86
Rogers Communications	411,016.0	3,350	122,691	73.5%	100.0%	8/31/86
ITT	17,500,000.0	120,000	145,833	NA	NA	12/31/86
Honeywell	5,328,000.0	77,000	69,195	5.3%	100.0%	12/31/86
N.V. Philips	6,004,500.0	345,600	17,374	4.4%	7.1%	12/31/86
CAE Industries	332,929.0	5,160	64,521	73.2%	45.2%	3/31/86
Unisys	7,400,000.0	NA	NA	3.1%	100.0%	12/31/86
Litton Industries	4,521,000.0	55,000	82,200	5.0%	100.0%	7/31/86
Matsushita Electric of America	NA	NA	NA	NA	100.0%	12/31/86
Control Data	3,350,000.0	34,000	98,529	6.4%	100.0%	11/30/86
Hewlett-Packard	7,100,000.0	82,000	86,585	3.0%	100.0%	10/31/86
Unisys	7,400,000.0	NA	NA	2.3%	100.0%	12/31/86
Canadian Marconi	226,634.0	2,500	90,654	73.2%	92.9%	3/31/86
NCR	4,881,641.0	62,000	78,736	3.2%	90.0%	11/30/86

Source: ELECTRONIC BUSINESS

U.S. versus Japan in the year of the high yen

Comparing operating costs of Japanese electronics firms with those of the U.S., Japan once again fares well

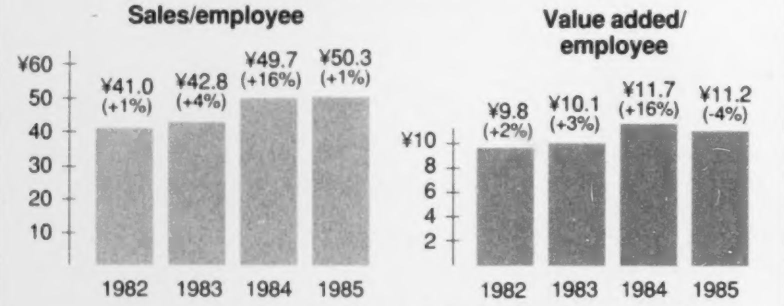
By Paula Doe

It was not a great year by any means, but the Japanese electronics sector as a whole did much better than some other segments of the Japanese economy. Nevertheless, Japan continued to outperform their U.S. high-tech counterparts in several key areas — including sales per employee, income per employee, and five-year compounded sales growth. And as usual, American firms outperformed the Japanese based on criteria which are usually associated with shorter-term gains — earnings, return on investment and return on equity.

Our analysis is based on data derived from company documents published by the top 20 electronics companies in the United States for fiscal 1985. We compared this information with data supplied by a recent report by the Bank of Japan. The bank's report, which analyzes the operating costs of 29 Japanese electronics companies in fiscal 1985 (for the period ended March 1986), also indicates that the Japanese electronics sector as a whole did better than most of the larger companies in Japan which rely heavily on exports. Also, during a period when the value of the yen rose about 30% in relationship to the dollar, the electronics sector, by and large, has reacted quickly to cut costs by finding cheaper outside sources of supply. But the industry still faces an eroding manufacturing base, excess domestic workers and sagging productivity.

Japanese productivity growth slows

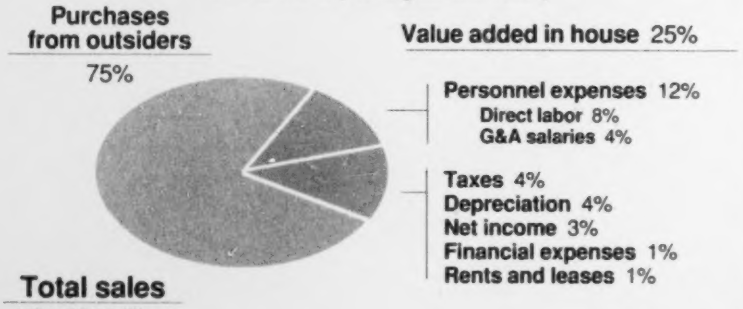
(¥ million and percent change from previous year)



Source: Bank of Japan, U.S. Department of Commerce

Composition of value added for major Japanese electronics companies

Fiscal 1985 (ending March 1986)



Source: Bank of Japan

The Bank of Japan study, which is obtained and translated each year by ELECTRONIC BUSINESS, provides a remarkable portrait of the cost of doing business in Japan. Compiled annually by the bank's research department, it offers extensive, and frequently exclusive, financial information from representative companies in Japan's computer and electronics sector on estimated operating costs. In this article and its accompanying charts, ELECTRONIC BUSINESS analyzes the bank's statistics, and compares them with those from our own database of the leading U.S. electronics companies.

Although the bank does not actually disclose which Japanese companies it talked to, ELECTRONIC BUSINESS is in a position to make some educated guesses — since most of the companies are publicly listed with capital of at least $5.5 million or ¥1 billion, based on a currency translation of ¥180=$1.

The general producers of electrical and electronic equipment — indicated in the main charts accompanying this article are Fuji Electric Company Ltd., Hitachi Ltd., Mitsubishi Electric Corp. and Toshiba Corp. The consumer electronics companies presumably include Fujitsu General Corp., Matsushita Electric Industrial Company Ltd., Matsushita-Kotobuki

Selected comparisons of financial data of Japanese and U.S. electronics companies

Data for fiscal 1985 (¥180 = $1)

	Top 20 U.S.-based electronics companies	Top Japanese electronics companies	Japanese sectors			
			General electrical and electronic equipment	Consumer electrical and electronic equipment	Telecommunication and other electronic equipment (including computers)	Electronic components
Total sales ($ millions)	$123,895	$118,291	$42,945	$43,768	$24,038	$7,540
Operating costs as a percentage of sales						
Cost of goods sold	48.2%	76.8%	78.8%	81.2%	69.4%	75.2%
Gross sales margin	51.8%	23.2%	21.2%	18.8%	30.6%	24.8%
Selling, G&A expense	25.8%	17.8%	17.8%	15.5%	25.3%	13.7%
Operating income	18.8%	5.4%	3.4%	3.3%	5.3%	11.1%
Pretax income	12.3%	6.7%	3.7%	6.1%	4.4%	12.7%
Net income	7.0%	3.5%	2.2%	2.9%	2.6%	6.4%
Dividends paid	3.0%	0.9%	0.8%	0.7%	0.8%	1.4%
Dividends as a percentage of net income	42.3%	26.7%	37.8%	23.6%	29.3%	22.3%
Productivity						
Sales per employee	$88,700	$267,100	$204,700	$343,600	$212,800	$219,200
Pretax income per employee	$10,900	$17,800	$7,500	$21,100	$9,500	$27,700
Returns						
Return on equity	13.2%	9.0%	9.7%	8.4%	8.9%	9.7%
Return on investment	10.6%	6.4%	5.9%	6.6%	4.7%	8.1%
Capital outlay/ net cash flow after dividends	104.4%	85%	108%	77%	101%	66%
Capital outlays as a percentage of sales	10.6%	5.6%	6.6%	3.8%	7.2%	6.5%
Five-year compounded sales growth	+11.0%	+12.3%	+9.2%	+10.6%	+16.9%	NA
Debt to capital	19.5%	25.8%	36.2%	17.7%	44.5%	13.1%
Total liabilities to equity	0.75%	1.4%	2.74%	1.04%	2.15%	0.47%
Current assets to current liabilities	2.18	1.70	1.19	1.41	1.42	3.02
Exports as a percentage of sales	34.4%*	39.3%	29.5%	50.3%	28.2%	36.3%

* Includes exports plus foreign operations

Source: Bank of Japan, ELECTRONIC BUSINESS

Electronics Industries Ltd., Pioneer Electronic Corp., Sanyo Electric Company Ltd., Sharp Corp., Sony Corp. and Victor Company of Japan Company Ltd. The makers of telecommunication and other electronic equipment presumably include Fujitsu Ltd., NEC Corp. and Oki Electric Industry Company Ltd. Component producers presumably include Alps Electric Company Ltd., Kyocera Corp. and TDK Electronics.

A balanced economy

Sales overall, the report indicates, were up about 3% in yen for fiscal 1985 (year ended March 1986) for the 29 representative electronics companies analyzed by the bank. Strong domestic demand for telecommunication and office automation equipment helped balance out poor results in semiconductors and exports. Earnings were off an average of about 15%. That is a far cry from the widely publicized 56% drop in earnings at Fujitsu Ltd. and 29% slump at Hitachi Ltd.

The Japanese companies' gross sales margins were down an average of 5%. Manufacturing costs climbed 3%, as overhead and labor expenses crept up. Selling, general and administrative expenses also went up about 7%, due to increases in salaries, advertising and miscellaneous expenses. Exports were down only 2%, as producers sacrificed margins to avoid raising prices.

This all adds up to a sobering 35% average drop in operating income. But many Japanese companies are loaded with cash from past fat years, and earned enough on their investments to counter lower operating earnings. The wealthy consumer electronics companies in fact got 3% of their total revenue from investment income — just about as much as they earned from operations. Overall, these healthy investment earnings meant net income for the sector as a whole slipped only from 4.2% to 3.5% of sales.

These figures are for the year ending in March 1986, when Japanese companies only had the high yen half of the year. But already the start of some structural changes is evident.

Most notable is the quick move to buy more outside from lower-cost producers. With some 75% of total revenue at the average Japanese electronics company already going to purchase goods and services from outsiders, these outside purchases were the quickest and easiest place for most companies to start cutting costs. In the first year of the high yen, the typical company bought 5% more outside. That pushed its own in-house added value down a corresponding 5%.

These figures are slightly misleading because they are for the parent company only, and therefore count purchases from subsidiaries as outside purchases. Still, they suggest how very significant this secondary layer of subsidiaries, affiliates, subcontractors and suppliers is to the major Japanese electronics companies. These smaller companies will be the ones that ultimately bear the brunt of the high yen. And any realistic comparison of Japanese and U.S. costs needs to take into account the much lower wage and overhead costs of these smaller companies.

Fewer administrators

The legendary Japanese productivity slipped badly in the first year of the high yen. The rush to source more components outside and offshore left the big Japanese electronics producers with excess workers. And falling prices meant that each worker had to churn out more units to achieve the same value of output. Revenue per employee was up about 1% (in yen) from the year before. But value added per employee fell 7%. And since personnel expenses rose 4%, value added

Japanese electronics sector's operating costs

Operating costs for fiscal 1985 (¥180 = $1)

	General electrical and electronic equipment	Consumer electrical and electronic equipment	Telecommunication and other electronic equipment (including computers)	Electronic components	Total and weighted average
Total sales ($ millions)	$42,945	$43,768	$24,038	$7,540	$118,291
Operating costs as a percentage of sales					
Cost of goods sold	78.8%	81.2%	69.4%	75.2%	76.8%
Cost of goods purchased	5.0%	36.3%	12.6%	23.7%	23.7%
Cost of manufacturing	71.2%	43.2%	58.2%	53.7%	55.5%
Material cost	42.4%	33.8%	39.2%	29.4%	37.9%
Labor cost	12.9%	5.1%	8.2%	8.6%	7.8%
Overhead	15.9%	4.3%	10.8%	15.7%	9.8%
Change in inventory	1.6%	1.7%	0.1%	0.5%	1.1%
Taxes	1.0%	0.1%	-0.3%	0.1%	0.0%
Other	0.0%	1.5%	-1.2%	-2.8%	-3.5%
Gross sales margin	21.2%	18.8%	30.6%	24.8%	23.2%
Selling, G&A expense	17.8%	15.5%	25.3%	13.7%	17.8%
Salaries and benefits	2.9%	3.2%	4.7%	3.8%	3.6%
Depreciation	0.2%	0.4%	0.9%	0.6%	0.5%
Taxes	0.5%	0.9%	0.6%	1.5%	0.9%
Leases	0.4%	0.4%	0.5%	0.5%	0.4%
Sales fees and commissions	0.4%	0.6%	2.1%	0.3%	0.9%
Advertising and promotion	0.9%	1.4%	1.1%	1.3%	1.2%
Shipping	2.0%	1.1%	2.3%	1.6%	1.6%
Other	10.5%	7.5%	13.1%	4.1%	8.7%
Operating income	3.4%	3.3%	5.3%	11.1%	5.4%

Source: Bank of Japan

Japanese electronics sector's value added

Value added data for fiscal 1985 (¥180 = $1)

	General electrical and electronic equipment	Consumer electrical and electronic equipment	Telecommunication and other electronic equipment (including computers)	Electronic components	Total and weighted average
Value added					
Value added per employee	$54,200	$67,200	$57,100	$72,400	$64,000
Personnel expense per employee	$32,200	$28,800	$29,900	$27,600	$29,300
Value added per dollar personnel expense	1.68	2.34	1.91	2.62	2.20
Breakdown of value added (as a percentage of value added)					
Net income	8.3%	14.8%	9.5%	19.7%	13.7%
Personnel expense	59.5%	43.0%	52.5%	38.5%	46.6%
G&A, salaries	10.9%	16.2%	17.4%	11.3%	6.9%
Manufacturing, labor	48.5%	26.6%	35.0%	26.9%	14.8%
Financial expense	5.4%	4.8%	7.4%	2.1%	5.0%
Leases	1.4%	1.9%	1.8%	1.4%	1.7%
Taxes	7.5%	21.6%	9.2%	23.5%	17.0%
Depreciation	17.9%	13.9%	19.6%	14.7%	16.0%
Value added	100.0%	100.0%	100.0%	100.0%	100.0%
Breakdown of expenses (as a percentage of sales)					
Personnel expense	15.8%	8.4%	14.1%	12.7%	11.7%
Financial expense	1.4%	0.9%	2.0%	0.7%	1.2%
Depreciation	4.7%	2.7%	5.3%	4.9%	4.1%
Variable costs	54.0%	72.9%	50.8%	59.0%	62.1%
Fixed costs	42.3%	20.9%	44.8%	28.3%	31.2%
Break-even point	92.0%	77.2%	91.0%	68.9%	80.9%

Source: Bank of Japan

Notes on tables

The Bank of Japan selects the major companies it considers representative of each sector for its annual financial analysis of the Japanese industry. Primarily these are publicly listed companies with capitalization of $5.5 million, or ¥1 billion, or more. The bank does not identify the companies individually, but the major members of each category are fairly clear. All figures are for parent company only.

COMPANY CATEGORIES

The general producers of electrical and electronic equipment are Fuji Electric Company Ltd., Hitachi Ltd., Mitsubishi Electric Corp. and Toshiba Corp.

The consumer electronics companies presumably include Fujitsu General Corp., Matsushita Electric Industrial Company Ltd., Matsushita-Kotobuki Electronics Industries Ltd., Pioneer Electronic Corp., Sharp Corp., Sony Corp., Sanyo Electric Company Ltd. and Victor Company of Japan Company Ltd.

The makers of telecommunication and other electronic equipment presumably include Fujitsu Ltd; NEC Corp. and Oki Electric Industry Company Ltd.

Component producers presumably include Alps Electric Company Ltd., Kyocera Corp. and TDK Electronics.

FINANCIAL CATEGORIES

Manufacturing overhead includes power, depreciation, leases, property taxes, maintenance and outside processing.

Number of employees is the average for the year and does not include temporary workers.

Capital outlays are the increases in property, plant and equipment, less depreciation.

Debt/total capital is long-term debt/long-term debt plus equity.

Personnel expenses include all wages and salaries, health and welfare benefits, severance pay, pensions and bonuses.

Break-even point as a percentage of sales is (fixed costs/[1 - (variable costs/sales)])/sales.

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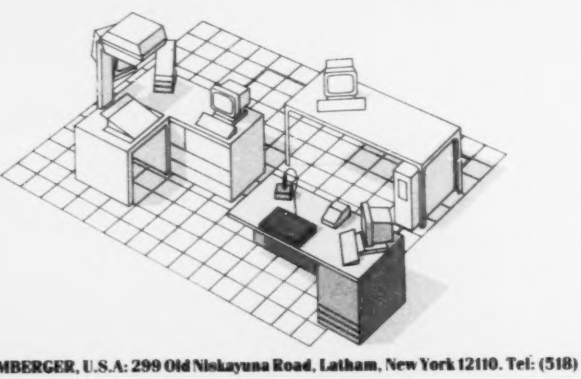

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per dollar personnel expense was off nearly 10%.

Even with the high yen, the Japanese still maintain an advantage in personnel costs. Production labor costs are still a little lower. But more significantly, they spend far less on multiple levels of management. The U.S. Department of Commerce figures a production worker cost a U.S. electronics company $13.20 an hour in 1985, compared with $5.25 an hour for a Japanese electronics company, at the average exchange rate for that year of ¥238.5=$1. At the March 1985 rate of ¥180=$1, that is $6.96. Even at ¥150=$1, the Japanese rate is still only $8.35.

At $13.20 an hour, compensation for a U.S. electronics worker for a year of regular 40-hour weeks comes to some $27,500 a year. The major Japanese electronics companies averaged personnel expenses (including benefits) of only $29,300 per employee at ¥180=$1 for both management and labor.

The legendary Japanese productivity slipped badly in the first year of the high yen

Since production labor accounts for only perhaps 2% of total production costs, far more significant Japanese savings may come from fewer, lower paid administrators. At the major Japanese companies, 8 cents of every dollar of revenue goes to pay people involved in making things (including plant management), but only 4 cents goes to pay all other employees.

In part this is because the Japanese save on marketing expenses by selling much of their equipment on an original equipment manufacturing (OEM) basis to resellers, instead of having to maintain their own salesforces. But they also seem to have simplified their systems to reduce their overhead. Even though the typical ratio of indirect to direct labor in U.S. industry is 1:1 or 2:1, for Japanese companies it is closer to 1:2, according to Michael McGrath, a consultant with Pittiglio, Rabin, Todd & McGrath.

"We do things multiple times," explains McGrath. "We have someone place an order with a vendor every month, and then call two weeks later to check on it. The Japanese just tell the vendor to send 100 a week. They've simplified things." ☐

Smart power: Micro mix makes a macro market

The promise of smart power has outpaced the reality. But the equation is changing as the market finally powers up

By Mike Leibowitz

Smart power semiconductors received a tremendous amount of promotion from vendors during 1986. A projected flood of components, which marry logic control with power switching, promised to revolutionize the design of electronic equipment in only a few years. This prospect began to excite consumer, office, and industrial equipment manufacturers almost as much as it excited component manufacturers which had targeted smart power as a burgeoning product area. But the flood is now overdue.

"It's not going to happen as quickly as people projected," says Roger Janikowski, smart power marketing manager for Motorola Inc. Larry Smart, general manager of General Electric Co.'s Integrated Power Semiconductor Department explains, "Everybody grossly underestimated how much technology and work had to be addressed to get this market up."

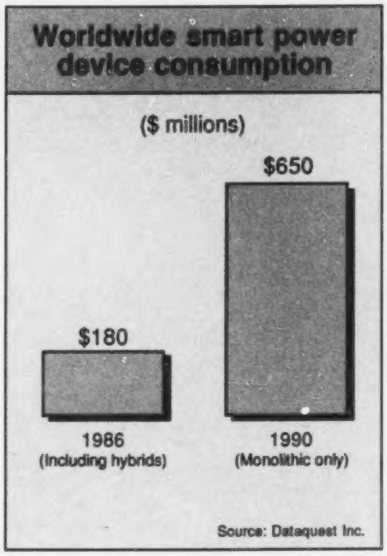
Potential users view smart power's slow progress from two distinct perspectives: For some it is a time to sit back and wait for the market to mature; for others, it is a period to leapfrog their competition with an emerging technology.

But at this early stage one prediction is certain. Many products are destined to be revolutionized by smart power. The big question is how soon.

THE MARKET

Smart power covers a very broad range of components, varying in power-switching capability from one to 1,000 watts, and containing as many as 400 equivalent gates of logic circuitry.

The applications for smart power include printers, copiers, disk drives, consumer appliances, industrial control products, telecommunication equipment, flat panel displays, power supplies, automobiles — virtually any product that includes a power device.


Worldwide smart power device consumption

Source: Dataquest Inc.

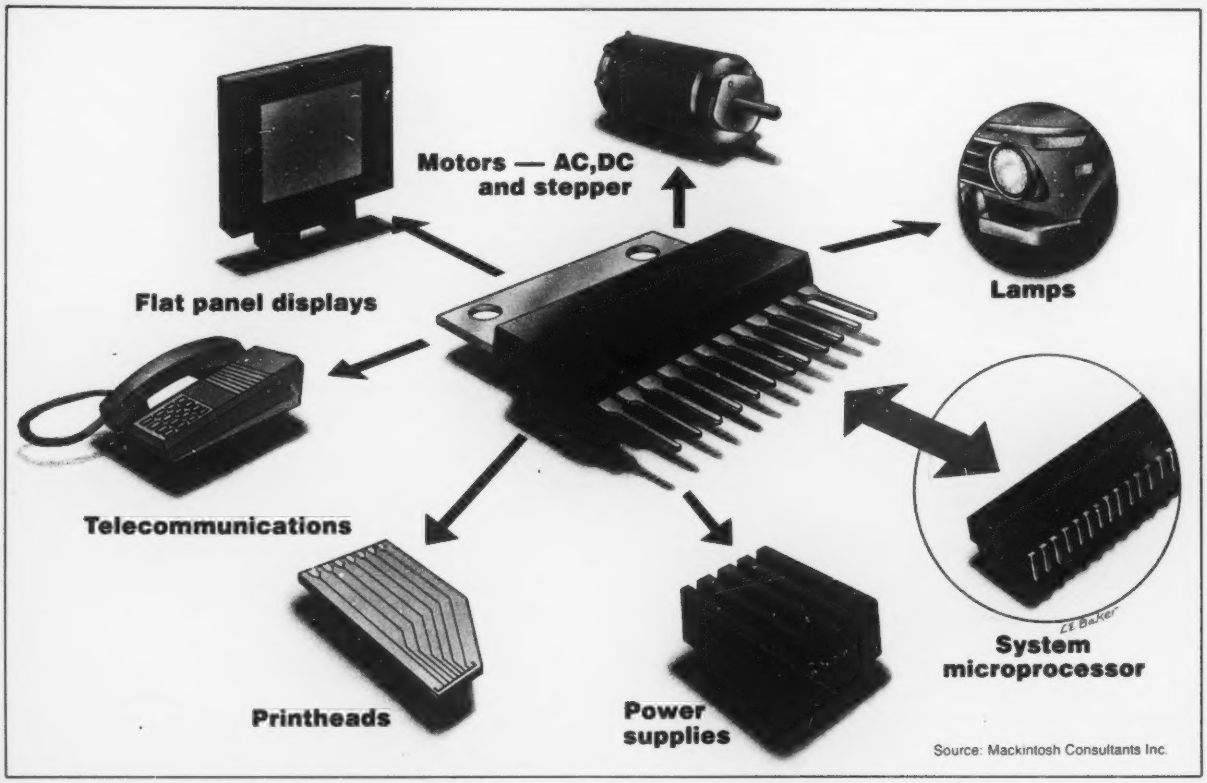
Smart power's chief benefits are in reducing system cost and size, but other benefits may also result, such as reduced power consumption, increased system reliability, and new system features. What smart power does depends on the amount of logic that is incorporated into the device.

For example, by including simple logic in a power device, a single component can switch a load such as a solenoid, motor or incandescent lamp and recognize if there is an open circuit, providing this diagnosis to a microprocessor. If there is a short circuit or the component overheats, it will recognize this also and shut down, protecting the power supply and the smart power component from damage. This fault detection and protection makes service quicker and less expensive.

By increasing the logic in a power device, the part can assume all the intelligence necessary to control a stepper motor or vary the speed of a DC or AC motor, depending on load and other criteria. A single smart power motor-control component is all that is needed between the microprocessor and a motor. It could replace up to 50 discrete components, resulting in a cost savings at the system level and allowing a product to shrink in size or add features. It could also reduce a product's power consumption.

By putting a substantial amount of logic on the power component, a whole new class of applications opens up, such as the multiplexing of automobiles, large consumer appliances and industrial process control systems. A multiplexed automobile would distribute the logic necessary to control headlights, motors, solenoids and relays by putting smart power devices at each power load. The automobile's central microprocessor would send instructions to the devices and receive status information over a single logic wire that circles the automobile. The scheme replaces an expensive and heavy wiring harness, while providing failure protection and service diagnostics.

There are approximately 40 vendors of smart power devices supplying a worldwide market projected to grow from an estimated $180 million in 1986 to $650 million in 1991, according to Ron Bohn, analyst for market research firm Dataquest Inc., San Jose, Calif. Although Bohn projects the market to more than triple during the next five years, he is very hesitant



Source: Mackintosh Consultants Inc.

SMART POWER COMPONENTS contain all of the logic and power circuitry necessary to control a wide variety of power loads, receive commands and return status to the system's main processor

Lori Baker

to speculate what is going to happen in the next year or two. "There is uncertainty over whether the market is taking off," says Bohn.

Two key factors are restraining smart power's takeoff: First, advances in technology are slower than expected; and second, equipment manufacturers are hesitant to make the production commitments necessary to drive those advances. Bohn calls this "a high-tech version of the 'chicken or the egg' puzzle." Which comes first — the vendor's technology or the equipment manufacturer's applications?

In trying to project how fast smart power will advance, most eyes turn to the technology's single largest projected customer: the automotive market. "There's a lot of belief now that automotive will be the driving force," says Bohn. Some, such as GE's Smart, project that automobiles will comprise roughly 50% of the eventual smart power market.

But automobile manufacturers are moving cautiously. "We have to be very careful in automotive that we don't go too far too fast," says Gene West, supervisor of advanced computer development at the Delco Electronics division of General Motors Corp. He says that the technology must be wrung out for cost savings and reliability. Delco does have a smart power device operating in 1986 automobiles. But, says West, "As I look over the state of smart power, I don't think it is very far advanced at this stage. It's not quite there yet, from my perspective, to just say pour it in all over the place. Once we have a level of success — that's when things will really take off."

The uncertainty over how fast smart power technology will advance certainly has not held back some equipment manufacturers. Trane Co., a division of American Standard Inc., is developing a residential heat pump system, containing GE smart power components, that consumes 25% to 30% less power than equivalent systems and offers unique comfort features. One portion of the system, an air handler, is already in production. "The payoff is fantastic," says Louis Chaump, Trane's vice president for engineering. "We're already seeing a payoff."

The worldwide smart power market is projected to reach $650 million in 1991

Trane is now well-positioned to fend off an expected influx of Japanese competition, says Chaump, but he acknowledges that they were pushing technology when they first approached vendors eight years ago. "It wasn't like we came along and cherry-picked it. It was a lot of skunk work. We invented technology."

Although a few standard smart power products have hit the market, custom designs dominate. Standard products being delivered include smart switches, motor controllers, display drivers, telecommunication switches and line-interface circuits. This is expected to grow. Says General Electric's Smart: "Those products that are custom today will become generic-standard industry products in automotive, EDP, and telecommunications." He projects that when the technology matures, standard products will make up 80% to 90% of the market. But, at least for the next few years, many expect that custom work will continue to be the major part of smart power and the driving force behind its advances.

COST OF ENTRY

The four reasons equipment manufacturers will go to smart power are "cost, cost, cost and performance," says Derek Lidow, executive vice president of International Rectifier. Lower system costs may indeed turn out to be a principal reason, but getting smart power into the end product ini-

THE TECHNOLOGY

Combining logic and power

Designing, fabricating and packaging smart power chips at a practical cost is a trick for chip makers. The difficulty is in combining high-voltage, high-current switching structures with logic at a price customers are willing to pay.

Today, vendors offer monolithic smart power chips capable of controlling a single load up to 100 volts and 10 to 20 amperes. Monolithic chips can switch multiple loads up to 300 volts and 300 milliamperes; or switch loads up to 150 volts and 1.5 amperes. As the various techniques are refined, vendors will undoubtedly reach greater voltage and current limits, and costs will go down for products at today's limits.

Is smart power monolithic or hybrid? Many disagree. A number of manufacturers offer hybrid solutions for high-power and logic-intensive applications that would be too expensive to implement monolithically — and call it smart power. They argue that smart power defines a function at the package level. Others say no; monolithics are the force behind smart power — this is the technology that will ultimately produce the greatest savings.

Just about everyone agrees, however, that hybrids will always be a used at the very high end of smart power technology, beyond the capabilities of monolithics. According to Derek Lidow, International Rectifier Corp.'s vice president for marketing, there are "a limited number of things you will want to integrate on a monolithic chip," namely, circuitry that is directly related to the power function. Lidow projects that complex logic such as a 16-bit microprocessor could never be efficiently integrated into a smart power chip; the microprocessor would run too hot and the power circuitry would run too cool to make such a device practical. "Here, hybrids will make sense," says Lidow.

Bill Numann, Siliconix's power IC marketing manager points out that as power level goes up, the power section consumes a greater portion of the chip area. Instead of putting a substantial amount of silicon through the numerous processing steps required for just a small area of logic it would be cheaper to separate it out. "Why complicate a major part of your chip?" asks Numann.

Hybrids will always be used at the very high-end of smart power, beyond the capabilities of monolithics

Vendors of monolithic devices are pursuing a number of routes in the race to boost power capability and lower costs. Mixed technologies dominate today, offering the best characteristics of two IC technologies on a single chip. There are three types of mixed technologies: BiMOS, integrating a bipolar power section with CMOS logic; DMOS/CMOS, combining a DMOS vertical power structure with CMOS logic; and CMOS/DMOS, joining a lateral power structure in DMOS with CMOS logic.

BiMOS, developed in 1978, was the first mixed technology and is presently used at the low end: medium-speed, low-current levels of application up to 100 volts.

DMOS/CMOS and CMOS/DMOS are the newest mixed technologies and the ones expected to have the greatest growth. DMOS/CMOS, with its vertical power structure, draws current vertically to the substrate of the die, allowing it to handle a greater amount of current while consuming very little silicon for voltages less than 400 volts. The drawback is that a vertical structure allows only one switch to be integrated on a chip, prohibiting it from multichannel applications.

The lateral structure of CMOS/DMOS uses conventional linear IC technology to integrate medium-current switches onto a single chip. It consumes a great deal of silicon and is only practical for low-current, high-voltage applications but since it allows multiple switches on the same chip, it is the solution for multichannel smart power applications.

Bipolar, expected to continue losing ground to mixed technologies, was the first smart power technology, dating back some 12 years. Bipolar combines I^2L logic, linear circuits and power PNP transistors. Today, bipolar competes with the other technologies primarily in the high-voltage, multichannel, logic-intensive area.

tially is likely to be expensive.

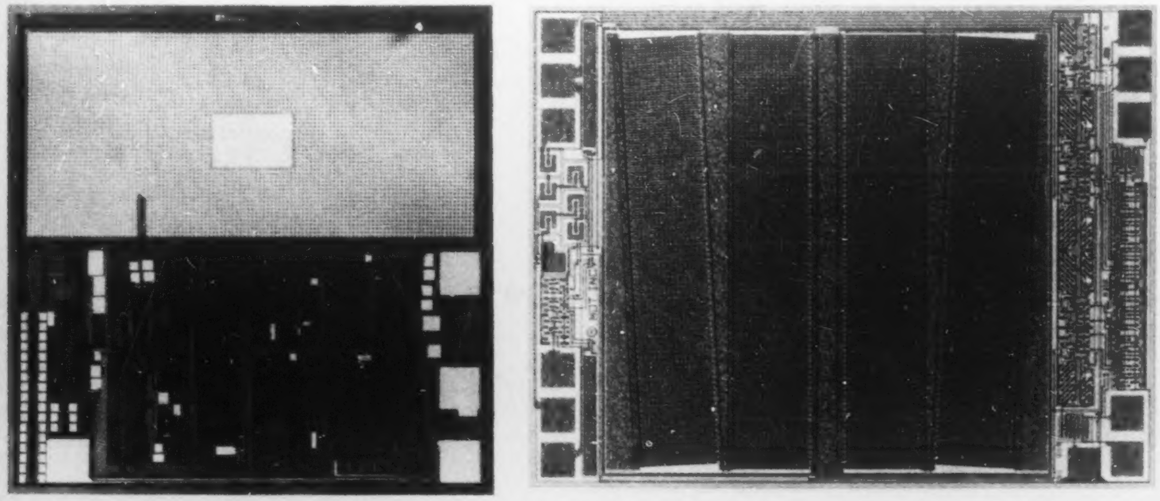
Finding a standard product to fit a particular application will require some luck. There are few standard smart power devices on the market, such as smart switches, power motor controllers, telecommunication circuits and display drivers.

For a custom design, the cost depends on a number of factors. One is complexity. Designs that push technology can send design costs soaring and result in a low-yield, high-price chip.

For high-power, logic-intensive designs, a hybrid may be the cheaper smart power device. It will certainly result in much lower design costs. According to Derek Lidow, International Rectifier's executive vice president for marketing, custom hybrid design costs range from \$3,000 to \$30,000, compared with \$500,000 for a monolithic design. Lidow, whose company does both monolithic and hybrid designs says that it takes between six and 10 weeks for hybrid prototypes and up to 20 months for the first prototype of a monolithic design.

Motorola's Janikowski pegs typical custom monolithic design costs at between \$100,000 and \$180,000 for a proprietary design. Before taking on a design they look at other strategic factors, such as the likely dollar value of the program, possible sales impact on other products, how successful they will be in the first prototype, and what they might learn from designing and manufacturing the chip.

At Silconix, William Numann, marketing manager for power integrated circuits (ICs), says that a monolithic design can cost as little as \$80,000, if it can be built with an available process, or as much as \$300,000 if it must be built with chips requiring new process development. They look for a



MOTOROLA's MPC1500, (left) 35 volt, 16 ampere High Side Switch. Its vertical power section occupies 50% of die. Overall chip measures 170 × 170 mils. **The MPC1710** (right) H-Bridge Motor Controller utilizes a lateral power section. Eighty percent of the die is power circuitry. It measures 100 × 130 mils.

How well vendors can isolate power sections from logic determines, to a great extent, the power-handling capability of the chip. Chip makers use three main isolation techniques to separate power structure from logic. Junction isolation is the most common, and relies on a reverse-biased PN junction to achieve moderate isolation. It is an expensive method at high voltages because thick epitaxial layers and considerable silicon are necessary. At above 100 volts, techniques must be used to reduce surface field effects that disrupt the logic. Junction isolation's advantage is that it allows great flexibility in the design of the power circuit.

Self-isolation, which reverse biases the junctions of the other components, is less expensive due to the elimination of the epitaxial layer but is limited in the amount of current it can handle.

Dielectric isolation offers the best isolation and considerable density, but is also the most expensive. Through a complex sequence of processing steps, dielectric tubs are formed to isolate the power components from the rest of the chip. This expense will decrease as better base wafer-processing equipment is developed.

Packaging is an area that also needs further development as vendors deal with a lack of suitable standard packages. The need for conducting heat away from a chip becomes paramount when logic is combined on a chip — a problem that will get worse with new, higher power devices. Package design is expensive and not particularly glamorous. But it will receive increasing attention in the future, otherwise, vendors will have no home for their hot chips.

Considerable near-term gains are expected in monolithic smart power technology says Mackintosh Consultants Inc. of Natick, Mass. Their worldwide survey of smart power projects that, by 1990, development work in DMOS/CMOS will yield vertical, single-channel chips having voltage and current ratings of up to 1,000 volts and 80 amperes. The firm expects that worldwide attention will be directed toward CMOS/DMOS technology resulting, by 1990, in lateral multichannel chips that can handle up to 700 volts and 4 amperes. BiMOS is anticipated to increase its voltage to 250 volts. Junction isolation is expected to move beyond its present limitations to 1,000 volts, through the use of special charge-control techniques. ☐

minimum $500,000 production commitment from customers for product delivered over a period of 18 months.

Some chip makers are negotiating development and production costs based on obtaining marketing rights to the product. GE, for example, assumed all development costs for Trane's heat pump application. Trane benefits by eliminating component development costs and reaping the benefits of lower production costs providing the device takes off. Chaump points out that although his competitors will someday be able to buy the device, the design of the system is still critical; also, by the time Trane's competitors catch up the company will be developing another system.

Semicustom, cell-based design is expected to come to smart power in the next year or two, somewhat reducing the long development cycles and today's high costs of certain hand-packed designs. The benefits will not be as great as in conventional standard cell work; there will still be a great deal of manual design work required, cautions Lidow of International Rectifier. Mackintosh Consultants Inc. of Natick, Mass., expects that by 1990, 16% of smart power chips will be semicustom designs.

THE COMPETITION

After deciding to use smart power, "the next thing you have to do is decide who you want to marry," says Trane's Chaump. Indeed, vendor-customer relationships have to be exceptionally close in smart power designs. Often, the design is a custom one. If so, the customer must communicate effectively with the vendor so that chip designers fully understand the system environment. Once the design is completed, there is no running off with the masks and getting it produced elsewhere; each chip maker virtually has his own process. The market has yet to see second-source agreements on custom, or for that matter, standard smart power products — except in the area of high-voltage, low-current components. Equipment manufacturers are warned: Choose someone you will want to be with for a long time.

Delco Electronics' West emphasizes the importance of a close working relationship with a vendor. "We sometimes don't always communicate everything we need to communicate on a piece of paper," he says. In developing a smart power chip, West cautions: "It's not: throw a spec over the fence and wait for the first silicon to come back and hope it works. A lot of dialogue needs to go on — a willingness to work together."

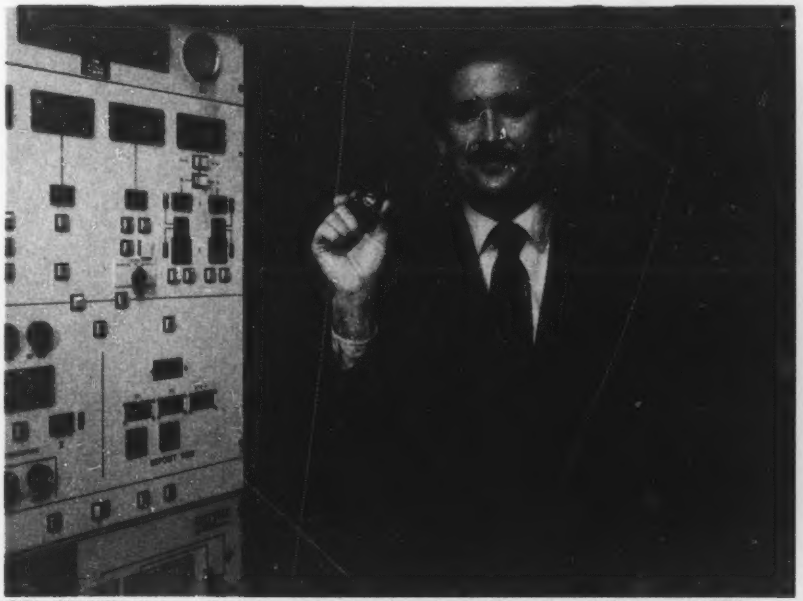
The approximately 40 smart power vendors worldwide range from established companies to start-ups; from firms steeped in power technology to those whose expertise is primarily in ICs; and from semiconductor giants to small specialty houses.

The major players today, according to Dataquest, are GE, International Rectifier, Motorola, SGS, Siemens and Siliconix. Other players include Mostek, Sprague, Supertex, Telmos and Unitrode. Start-ups include Elantech Inc., Integrated Power System and IXYS Corp. Besides those presently in the smart power market, many others are considering entering. "It's an open market today," says Dataquest's Bohn.

Among those eyeing the market are the Japanese. Right now, the Japanese are developing capability internally and watching how the market shapes up, says Bohn. Toshiba Corp., for example, has gained considerable experience developing smart power hybrids for applications such as the Bullet Train. It is unclear when Japanese firms will join the market, but some such as Mackintosh Consultants expect them to do so in 1987.

The companies that succeed in smart power will be the ones with expertise in power semiconductors, claim those vendors that have entered smart power from the power side. Dataquest's Bohn agrees. Smart power's biggest challenges, he feels, are in power technology.

Other factors are important as well, namely, financial commitment and involvement in key markets such as automotive. Motorola is considered, by many, likely to succeed for all these reasons. They have considerable experience in power devices, a very broad manufacturing base and background in the crucial automotive market.



GE's SMART: "I don t think the technology is going to be mature until the mid-1990s"

General Electric is a vertically integrated manufacturer, which allows it to develop products based on experience gained with in-house applications. They appear to be staying in hybrids, however; this may later remove them from a good part of the monolithic smart power market.

International Rectifier recently signed a five-year development agreement with National Semiconductor, forming a potentially good combination of IR's power expertise and National's analog IC capability. Many are looking at the alliance with interest to see how well it will work.

The companies that succeed in smart power will be the ones with expertise in power semiconductors

Siemens benefits from having a broad manufacturing base and expertise in power semiconductor technology. The company has the resources, many believe, to continue and grow as a smart power player in the North American market.

It is almost impossible to project, at this point, which players will emerge in smart power's top 10. The next few years are critical, as firms enter the field and jockey for position before the expected shakeout during the early 1990s.

THE OBSTACLES

The obstacles to using smart power today all arise from its immaturity. High component costs, long custom development cycles, limitations on power and logic, and the lack of standard products and packaging are all factors that make using smart power difficult and sometimes risky. These will diminish as the technology progresses.

Although analysts such as Dataquest's Bohn prefer not to speculate about the near-term prospects for smart power, vendors will take a guess. Says Motorola's Janikowski, "The dam has got to break soon." He thinks 1987 will be the introduction year for many new products and 1988 will be a big revenue-growth year. Lidow of International Rectifier says that there will be "some blockbuster ICs in '87 but you'll be able to count them on one hand." He does not expect a lot of smart power devices on the market "until 1988 or beyond."

For now at least, equipment manufacturers will have to choose between waiting for the technology to mature and jumping on the smart power bandwagon early. Those that decide to use smart power within the next few years may be the ones to derive the greatest benefits from the technology by getting a substantial jump on their competition. Are the potential benefits worth the costs and risks? Only a detailed study of the particular application will answer that question.

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Electronic Business

Spending trends for design automation systems

Connectors: Plugging into a $4.6 billion market

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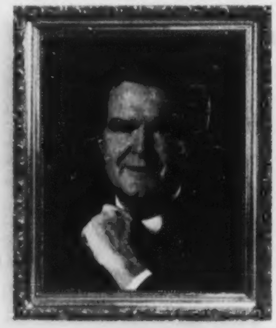
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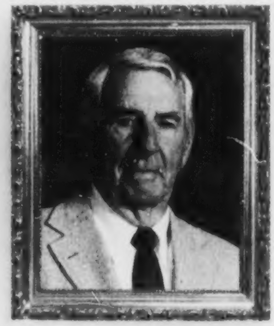
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The Best Executives of 1987

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Digital Equipment Corp.

James E. Olson
AT&T Co.

Bernard L. Schwartz
Loral Corp.

Alan F. Shugart
Seagate Technology

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Electronic Business

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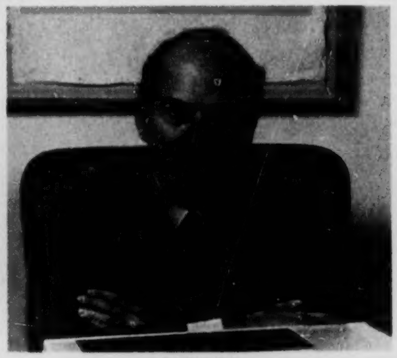

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BPA ABP

The communication equipment outlook starts to brighten

The situation, much improved in the first quarter, will strengthen as the business upturn takes hold

Although the fallout from deregulation continues to upset the communication industry applecart, the dust is beginning to settle. As a result, a number of markets are beginning to stabilize and equipment vendors can look forward to a more productive 1987, especially during the final two quarters.

After a relatively flat 1986 — plagued by end-user uncertainty and price wars that skewed a number of market segments — communication equipment vendors can expect a production ramp-up that will accelerate during 1987 and continue through the first half of 1988, according to Cahners Economics predictions.

The overall communications index is expected to rise 5% in 1987 — a much rosier outlook than the mere 0.7% increase that took place in 1986 — and then climb another 4% during the first two quarters of 1988 before tapering off the second half of next year.

Orders for communication equipment jumped 36% at the close of last year as military demand rebounded from a sluggish period in the fall. Despite that burst in activity, last year showed a loss of 0.4% to $69.2 billion in production. This weakness in demand held back shipments throughout 1986 and resulted in a subpar performance for the year. However, Cahners' in-house economic forecasting unit suggests that backlogs this year will help prop the industry up, pushing up actual shipments by a modest 6.5%.

Meanwhile, overall U.S. industrial production is forecast to increase 6.2% this year and then slow to 2.2% during 1988, according to Cahners economists. This is due to the accelerating growth of the industrial activity, evidence of which is most visible in the apparent rebound in capital equipment markets.

On an even brighter note, shipments of telecommunication equipment are forecast to outpace production. That, at least, is the consensus among independent market researchers. According to estimates by research firm Dataquest Inc., a market research firm based in San Jose, Calif., U.S. shipments of telecommunication equipment are expected to grow from $22.3 billion to $24.8 billion during 1987, reflecting an increase of 11%.

One of the hottest ticket items for this year is equipment used in T-1 networks, which have the capacity to transmit digitized voice, data and video signals at speeds up to 1.544 megabits per second. The general consensus among industry analysts is that the T-1 equipment market will grow at an average of at least 35% per year.

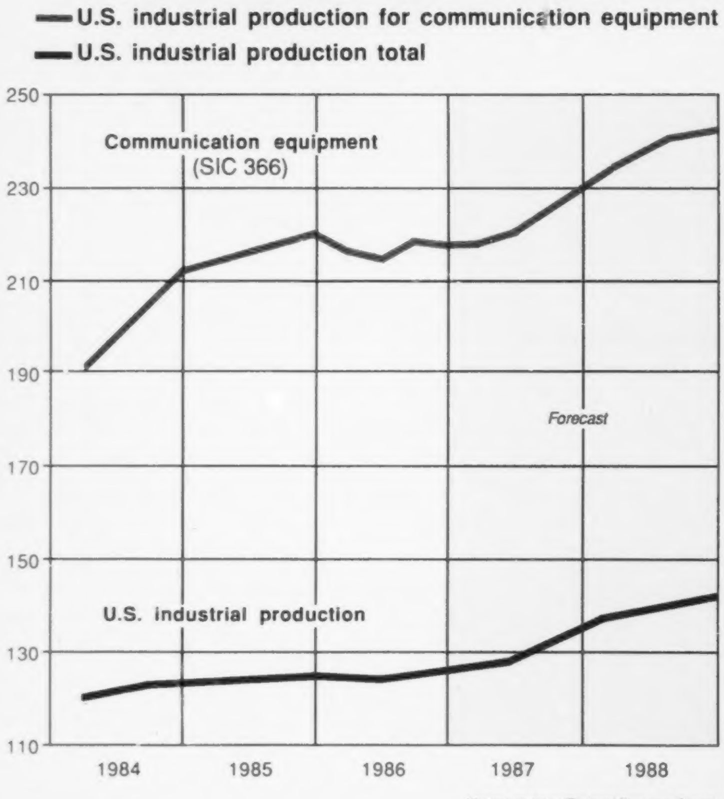
The electronics used in the building of fiber-optic telecommunication networks is yet another promising segment. Currently valued at $875 million, this segment of the transmission equipment market is expected to hit $1.026 billion by the final quarter of 1987, reflecting a hefty 17% growth rate, according to research firm Northern Business Information Inc.

Above all else, the proliferation of networks and the "network mania" that seems to permeate so many corporate offices today is having a positive effect on the datacommunications equipment market.

CAROL SUBY

Communication equipment

Industrial production indexes, 1977 = 100



Historical data: Federal Reserve Board
Forecast: Cahners Economics

Electronic components and accessories

Many categories of electronic components, including capacitors, connectors and some types of semiconductors, experienced mild upward price pressures in late 1986. This pushed industry-wide prices up 0.3% in the fourth quarter, to a level which was more than 2.7% above a year earlier. This compared with an increase of just 1% for the entire first half of the year. Prices should continue to push upward over the course of 1987 as the unfolding business recovery gains momentum. Following a modest overall increase of 1.8% in 1986, prices are expected to climb approximately 3.2% this year and 4.4% next year.

Capacitors

Capacitor prices, which had fallen for seven consecutive quarters, turned up in the fourth quarter of 1986, averaging 0.8% higher than they did in the previous quarter. Two factors were chiefly responsible for this reversal: a pickup in demand from the computer makers and recent changes in exchange rates. For example, the dollar's decline against the major European and Japanese currencies has caused imported aluminum foil to become more expensive, prompting some manufacturers to increase prices on electrolytic capacitors now that demand is increasing. There will be continued spot increases throughout 1987, pushing capacitor prices up 0.9% annually; that compares with a 2.5% decrease last year. A further rise of 3% is forecast for 1988.

Connectors

In the fourth quarter, connector manufacturers raised their prices by an average of 1.1%, about equal to the increases in the prior two quarters. This brought the overall 1986 price advance to 3.5%, the highest rate of market inflation in five years. Although demand will improve gradually throughout 1987 and the underlying rate of U.S. inflation will be rising, connector prices are expected to climb at a slightly slower 2.3% pace this year. The reason: price competition will stay intense between domestic and foreign suppliers while excess capacity remains unused. An increase of about 2.9% is expected next year.

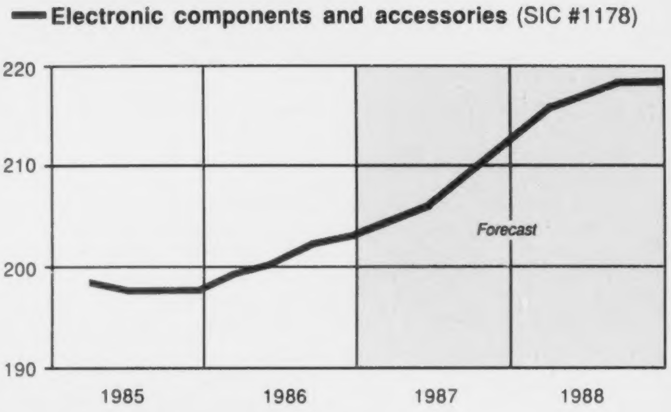
Resistors

Resistor prices rose a modest 0.1% in last year's fourth quarter, bringing the overall 1986 increase to 1.9%. This represented a slight decline from the 2.7% rise posted in 1985. The recent turnaround in electronic end-equipment markets suggests that resistor manufacturers will see a slow but steady improvement in demand this year. However, the gains are expected to produce little change in prices. Prices are expected to edge up just 1.1% this year and about 0.5% in 1988.

Producer price indexes

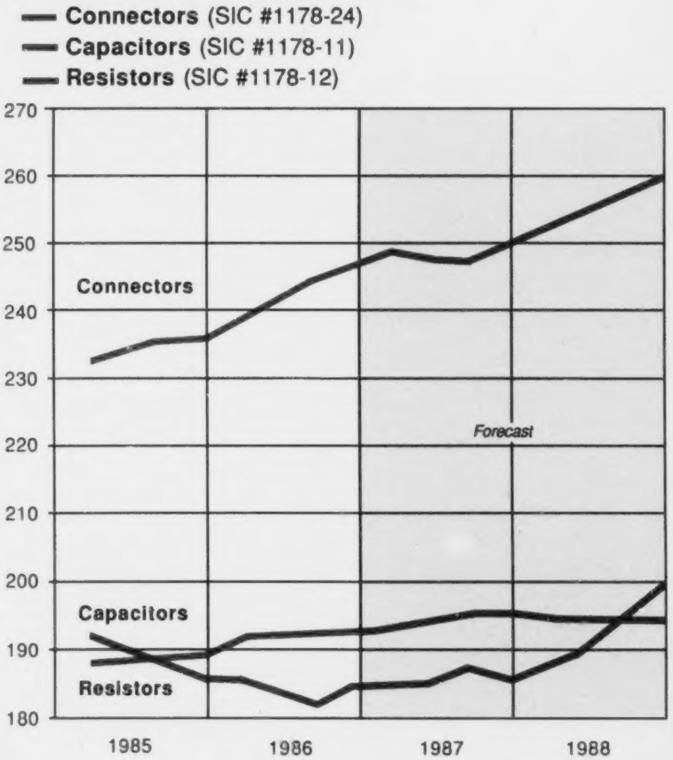
Electronic components

December 1967 = 100, quarterly averages



Passive components

December 1967 = 100, quarterly averages



Historical data: Bureau of Labor Statistics
Forecast: Cahners Economics

Electrical machinery

(SIC 36)

New orders

Manufacturers of electrical machinery received $52.2 billion in new orders in the fourth quarter of 1986, up from $49.0 billion in the previous quarter. This sharp uptick in activity boosted annual volume to $199.2 billion, an increase of 5.4%. Nearly half of the year's growth came from two segments: television and radios, where orders grew 17.5%; and electronic components, where there was a 7.9% rise in demand. The only area to lose ground in 1986 was communication equipment. Growth is expected to slow in defense and consumer-related segments this year, offsetting the improvements that are ahead for other electrical machinery markets.

Unfilled orders

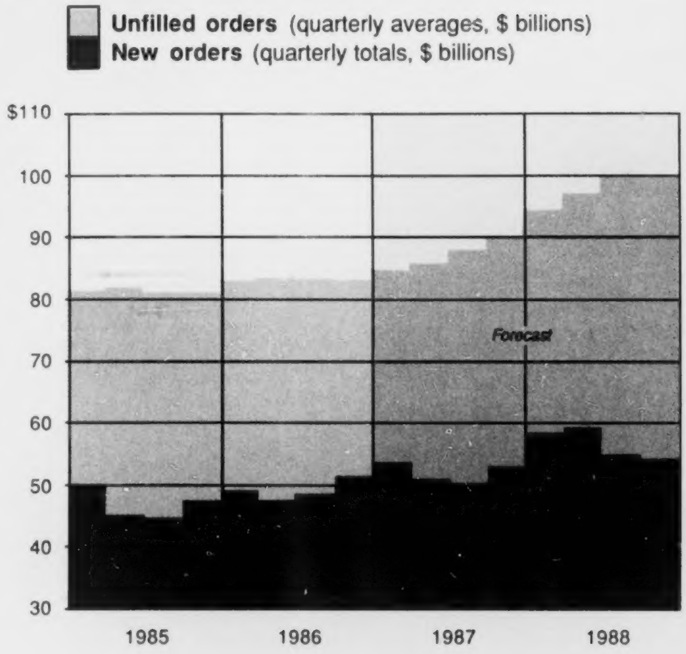
Manufacturers' order backlogs continued to show little change in last year's fourth quarter; they averaged $83.8 billion, a decrease of merely 0.3% compared with the third quarter. Annually, backlogs grew just 2.4%; this means that there was little actual growth, since the overall rate of U.S. inflation approached 2% for the year. Sluggishness in consumer and defense-related markets will prevent the overall electrical equipment industry from experiencing much backlog growth again this year; they are expected to increase just 4.2% this year, about on par with inflation.

Shipments

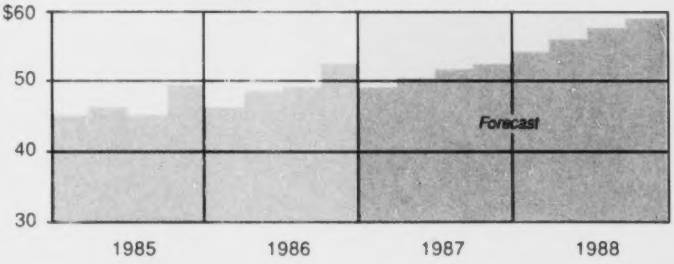
Electrical machinery manufacturers shipped an estimated $52.7 billion worth of products in the fourth quarter, an increase of 6.7% over the previous quarter and 7.8% over the fourth quarter of 1985. This strong year-end performance lifted annual shipments up 6.3%. Growth was paced by consumer-related markets (such as appliances and televisions) and by the defense segment of the communications industry. These areas will experience more modest gains this year, but the effects will be counterbalanced by a gradual improvement in other electrical and electronic equipment areas. Shipments are expected to climb 3.5% in 1987 and a stronger 11.2% gain in 1988.

Inventory-to-shipment ratio

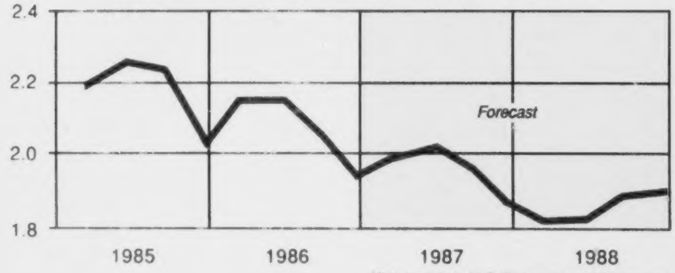
In last year's fourth quarter, total inventories (of raw materials, work-in-progress and finished goods) in the electrical machinery industry dipped 1.3%. Since shipment levels during the quarter rose briskly, the balance of manufacturers' inventories to shipments posted a sharp decline. The ratio averaged just 1.94 in the fourth quarter, down from 2.06 in the prior quarter and slightly below the level at the business cycle peak in early 1984. This suggests that inventories are now fairly lean relative to shipments. We expect manufacturers to maintain the current ratio for at least the next several quarters, keeping inventory growth in step with shipments growth.



Electrical machinery: Shipments
(quarterly totals, $ billions)



Electrical machinery: Inventory-to-shipment ratio
(seasonally adjusted, quarterly averages)



Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

Defense electronics: Not the best of times, but not the worst either

Defense spending is expected to remain flat, but the electronics content of procurement climbs

It's not the best of times for defense electronics companies. Pentagon spending is flat and the Democratic Congress is expected to keep a close watch on individual programs and future spending. Mergers and consolidations are restructuring the industry. Layoffs are rampant. And new contract regulations reportedly are eroding profits.

But for those companies that expect to survive the industry rationalization, it's not the worst of times either. "Despite inconsistencies, defense electronics remains a good business and a good place to be," says Bernard Schwartz, Loral Corp. chairman. Calling the current sluggishness just a "hiccup" in the procurement process, Schwartz expects current program stretch-outs to soon disappear as more compact and more efficient electronics systems replace old technology. "After the current shifting of gears," he says, "there will be sustained growth."

Schwartz is not alone in his optimism. Other defense electronics company executives and industry analysts have expressed similar views. In the face of a flat Defense Department budget, "defense electronics is still enjoying positive growth, both in absolute dollar terms and because electronics is growing as a proportion of overall defense systems," says Susan Pitts, an analyst with Alex. Brown & Sons Inc., the Baltimore-based investment banking company. "While the rate of growth is slowing, we feel most of the bad news about the industry" is under control, says Pitts.

Projections vary, but the Electronic Industries Association (EIA) predicts the electronics content of the Defense Department budget will grow about 8% over the next 10 years — from $53.5 billion in fiscal 1987 to $58 billion in fiscal 1996. The total defense budget, meanwhile, will increase only about 1% in the same period — from $280 billion to $283.9 billion. EIA suggests the electronics portion of the budget — including procurement, original equipment and research, development, technology and engineering — will actually decline slightly over the next few years but then rebound.

Electronic components and systems — especially in the command, control, communications and intelligence (C^3I) arena — are getting high priority as the services retrofit existing equipment. The emphasis is on reducing the size of electronic systems and increasing the commonality of components and subsystems. New technologies like gallium arsenide (GaAs) and 32-bit microprocessors will help sustain the growth, according to Schwartz. And if the planned Strategic Defense Initiative survives despite some cynicism in certain quarters of Washington, it could mean big bucks for defense electronics companies. Not surprisingly, companies supplying those products concur.

> The drive for denser, more efficient electronic systems is causing problems for some contractors

New chip technologies

"Gallium arsenide has open-ended potential," says Ronald Rosenzweig, president and one of the founders of 2-year-old GaAs integrated circuit maker Anadigics Inc. of Warren, N.J. "It's very clear gallium arsenide is a technology the DOD views as extremely strategically important." The Department of Defense will fund development, he says, and be the driver for commercial applications, as well. Rosenzweig points to the planned five-year $600 million Monolithic Millimeter and Microwave Integrated Circuits (MIMIC) program to build gallium-arsenide devices keyed to specific military applications. Phase I MIMIC contracts were awarded in late January.

By 1990, he projects, the GaAs market will top $1 billion. MIMIC is emulating the DOD's Very High Speed Integrated Circuits (VHSIC) program for very dense silicon chips. Although more expensive than conventional ICs, GaAs devices operate much faster than silicon devices and consume less power. They are also more resistant to nuclear radiation, making them well suited for military applications.

The drive for denser, more efficient electronic systems is causing problems for some contracts that are having trouble coming up with the required technology. "There are some sick mooses," says Donald Latham, assistant secretary of defense for command, control, communications and intelligence. It is necessary to learn from the difficulties experienced by problem programs if future efforts are to be a success, says Latham. For one thing, he says, there must be "more realism in initial specifications including software specifications."

Latham singles out such efforts as Hughes Aircraft Co.'s AMRAAM missile program and the Airborne Self-Protection Jammer (ASPJ) as problem programs. In the case of AMRAAM, Hughes must find a way to cram sophisticated electronics into a seven-inch diameter missile and at the same time accomplish multiple missions. Similar problems have cropped up with the joint Navy/Air Force program, ASPJ, which is two years behind schedule, according to Latham. The internal communications system must be small enough to fit into McDonnell Douglas Corp.'s F-18 and be diverse enough to also fit and work well in General Dynamic Corp.'s F-16. Prime contractors are ITT Corp. and Westinghouse Electric Corp.

As a result of technology problems on some defense programs, spotty profitability could hurt those companies trying to get back on track, says

Pitts of Alex. Brown. Programs to keep a close watch on, says Pitts, include Sanders Associates' INEWS, navigation electronic warfare system and TRW Inc.'s ICNIA, communications navigation system. "Uncertainty could be reduced if companies watch out for trouble programs," she says.

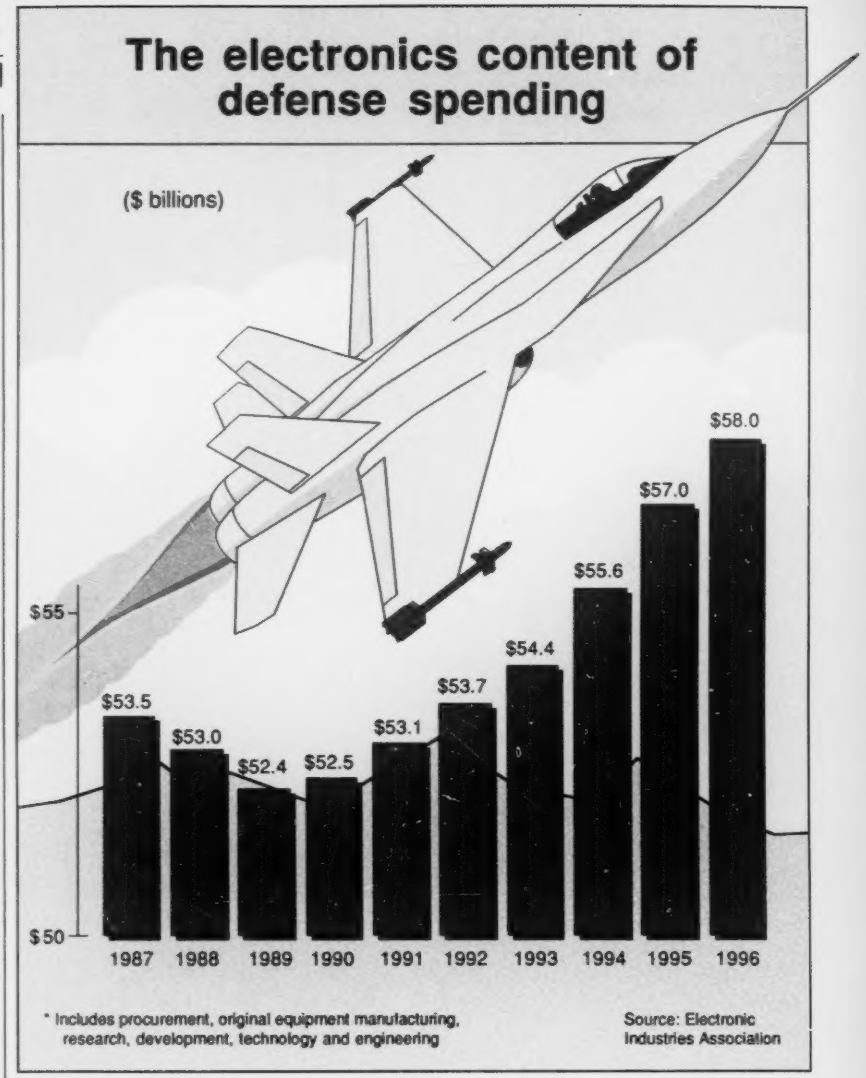
Scaling back

A number of contractors have cut back employment. Rockwell International, which wound down production of the B-1B bomber, laid off 6,800 last year. Honeywell Inc. is reducing its total corporate workforce by 4,000; Hughes Aircraft expects a layoff by the end of the year; and Northrop Corp., which canceled the F-20 fighter program for lack of interest, will reduce its workforce by 2,000 this year.

The defense electronics market and the fiber-optics segment of it are "lumpy," adds Albert Bender, president of Fibercom Inc., a manufacturer of fiber-optic communications, and data transmission products and systems. Bender expects a shakeout as companies merge and consolidate business. "There just may be too many companies chasing too little business," he says, although optimistic about his firm's potential business with the military. Fiber optics are well suited for defense applications, according to Bender, because of the small size and weight, immunity to nuclear blasts, increased security and long life.

Indeed, the defense industry consolidation has already begun. Loral, for example, acquired Goodyear Aerospace after pursuing Sanders, which eventually was purchased by Lockheed Corp. in August for $1.2 billion. ITT created a new subsidiary, ITT Defense Corp., consolidating its defense and space divisions. Honeywell Inc. bought the Sperry Aerospace Group for about $1 billion from Unisys Corp., the company formed by the merger of the Burroughs and Sperry corporations. General Electric Co., after buying RCA Corp., merged GE's Space Systems division with RCA's Astro-Electronics division. Also, GE's Military & Data Systems Reentry Systems business was combined with RCA's Automated Systems division to form the Federal & Electronic Systems Division.

Industry restructuring continues as the market evolves. "It's a changing and difficult defense contracting environment," says John Woodhull, president of Logicon Inc., the Torrance, Calif., defense software and professional services company. "But things are getting better now." For one thing, say Woodhull, the dust has settled following the 1985 Competition in Contracting Act. That law meant that sole source suppliers were no longer guaranteed follow-on business and had to spend considerably to bid on projects they had once been assured.


The electronics content of defense spending

* Includes procurement, original equipment manufacturing, research, development, technology and engineering

Source: Electronic Industries Association

Also, according to Woodhull, the continuing pressures to cut down waste, fraud and abuse have resulted in more paperwork and confusion of accounting.

Despite the "hiccup" in market conditions or "difficult environment," depending on who you talk to, a number of companies are enthusiastic enough about the future of defense electronics to beef up their military operations. LNR Communications, for example, hopes the government portion of its business will increase from about 35% of revenue, in the fiscal year ending this summer, to 50% in a few years.

"We want to take products that have found niche markets in the commercial world and find new markets in defense," says Sy Okwit, LNR president. In 1985, government-related business accounted for only 17% of the Hauppuge, N.Y., low noise reception, and communication equipment company. LNR makes solid-state communications receivers and transmitters and manufacturers certain key devices.

As Congress, the Pentagon and the White House continue to wrangle over defense spending levels, there are clear signs that electronics, at least, will continue to grow, albeit at a slower pace than in the past. "There is recognition from the top of the importance of C^{3}I and in the budget from DOD and Congress," says assistant secretary of defense Latham.

BETH KARLIN

What the weak dollar means to electronics

As the dollar slides, U.S. goods become more attractive overseas, and Japanese components are getting more expensive

By Bruce C.P. Rayner

Since 1980, the U.S. trade balance in high-technology goods has been deteriorating at an alarming rate. In 1986, for the first time in recorded history, the high-tech trade balance turned red — import growth outstripped export growth to the tune of $2.6 billion. The over-valued dollar and aggressive trade policies of some of America's trading partners have been partly to blame, but U.S. companies relocating offshore are also responsible.

Between 1981 and 1986, the U.S. current account balance (net trade of all goods and services) declined from a $6.3 billion surplus to a estimated $145 billion deficit. Most of that slide was due to the $130 billion drop in the merchandise trade balance (net trade in nonmanufactured and manufactured output) that sank to a record $170 billion deficit last year. While nonmanufactured trade in products such as oil and agriculture stayed more or less stable through this period, the manufactured goods trade balance went from a $10.5 billion surplus in 1981 to a $139.1 billion deficit in 1986, according to the Department of Commerce.

The American Electronics Association (AEA) reports that things are just as bad in electronics. According to Harry Lewenstein, manager of industry statistics at the AEA, the electronics trade deficit (including computers, telecommunications, components, consumer and medical electronics) for 1986 was $13.1 billion. That figure has been falling since 1980 when it peaked at a $7.4 billion surplus and has been in deficit since 1984. Also, Lewenstein says, the United States has had a persistent electronics deficit with Japan since the 1970s. In fact, the Japanese electronics trade deficit has gone from $3.7 billion in 1979 to $20.4 billion in 1986.

Now that the dollar is settling down from its all-time high, set in February 1985, the high-tech trade balance is expected to show some signs of improvement. Some are forecasting it will turn back into a surplus again in 1987, but the signs of a turnaround are still vague.

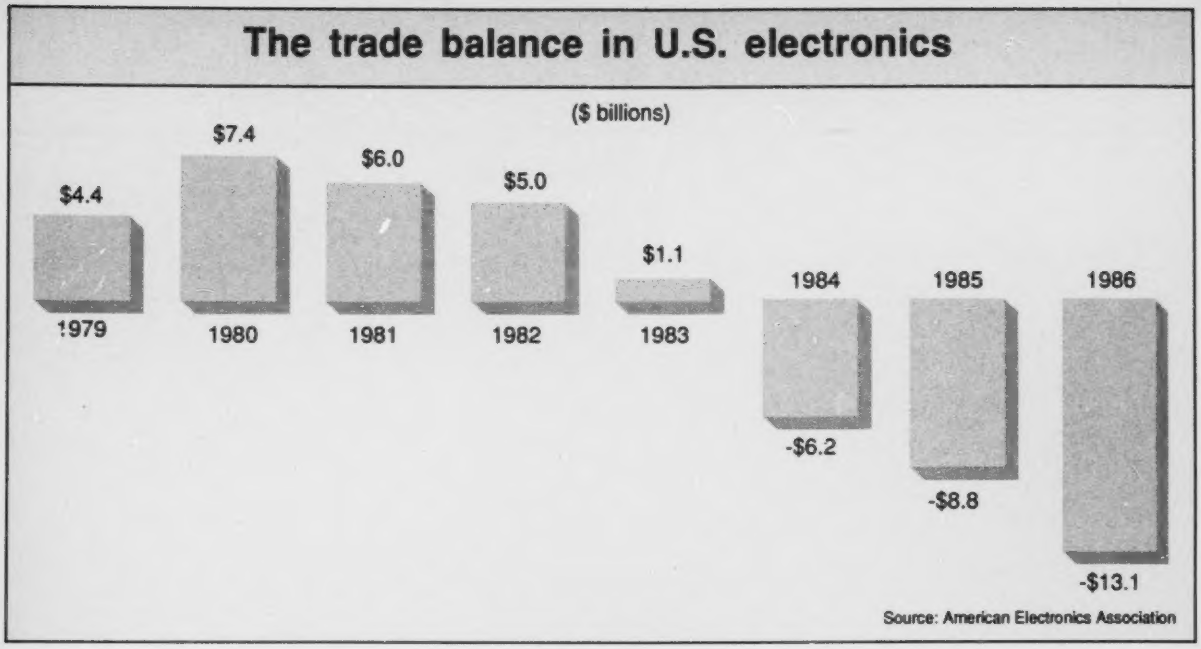
The electronics trade deficit for 1986 was $13.1 billion

Economists estimate that the lag between the dollar's drop and an improved trade balance is somewhere around 18 months. But it has been over 25 months since the dollar peaked and the trade balance is still far from healthy. Signs of improved exports, reopenings of onshore production facilities and a general reduction in the dependence on foreign-made goods have been slow to materialize. This indicates that other forces are at play in the marketplace — these include a still-sluggish world demand for electronics equipment and persistent economic uncertainty.

Many U.S. electronics companies are frustrated that their improved international competitive position is not translating into more foreign sales. Nonetheless, the mood is one of optimism for a pickup in 1987. Gerald J. Bojas, corporate controller at Compugraphic Corp. in Wilmington, Mass., expects the international market for electronic typesetting equipment to post stronger growth than the domestic market in 1987 because of the weaker dollar. Compugraphic, a $340 million company, does about 30% of its business overseas, he says, mainly in Europe but also in the Far East and South America. The only positive sign so far, reports Bojas, is that foreign sales are "more steady" than domestic sales.

As for the strength of the domestic market, the lower dollar should theoretically crowd out more expensive foreign goods. Not so, says chief financial officer John Rogers of Zytec Corp., a $50 million Minneapolis-based maker of power supplies. The Japanese, he says, are willing to keep prices competitive in order to preserve market share at the expense of profit margins. But some domestic manufacturers are starting to report some cracks in Japan's resolve as some cost increases are being passed along. But for other Far East competitors, many of whose currencies are tied to the U.S. dollar, their competitive position is not affected.

Although there has not been a flood of companies seeking repatriation in the United States, there is a noticeable trickle as a result of the rising yen. Earlier this year, for example, General Electric Co. of Fairfield, Conn., dropped Matsushita Electric Industrial Co. as a television supplier and began ramping up for big-screen tele-


The trade balance in U.S. electronics

Source: American Electronics Association

vision production in its Bloomington, Ind., facility. The reason for the move, GE said, was that Matsushita planned to pass on a price increase caused by the decline of the dollar.

For electronics companies that rely on Japanese components for their products, however, the dollar's drop is a mixed blessing. On the one hand, as the yen price of Japanese components starts to inch up, the price of U.S. products that rely on them also rise. But, at the same time, the dollar's decline is lowering the overseas price of U.S.-made products. As a result, some economists believe the U.S. trade balance has not budged because of the double-edged nature of exchange rates. Their suggestion is to let the dollar fall further.

For Termiflex Corp., a $5.2 million company based in Merrimack, N.H., currency fluctuations are also a problem, says Lynn Friedel, vice president for finance and administration. The company does about 10% of its hand-held terminal business in Europe but so far has not seen any improvement as a result of a declining dollar. Friedel says Termiflex sources about 25% of its component parts from Japan but has so far not seen any significant price increases. The potential is there, she concedes, for the rising price of foreign inputs to counteract the gains from the falling dollar. Still, she expects European sales to begin to pick up soon and is looking to expand the company's overseas business to 20% of total sales.

The Japanese market is also appealing to many U.S. electronics companies, but it is difficult to crack. "Penetrating Japan is a bit like penetrating the wall of China," says Kevin Walsh, controller of the Schlumberger Computer Aided Systems Group (CAS) of Schlumberger Ltd. "There are a whole series of other issues there that are not cost related."

Walsh says that in the European market, where Schlumberger is based, the competition from U.S. companies is getting tough. "We have people like Hewlett-Packard coming in and being very aggressive on pricing," he says. In response, Schlumberger's European operations have to rely on local increases in productivity to remain competitive.

Divining the dollar

The recapturing of market share depends on whether the dollar will stay down or start to rise again. Economists at the Bank of America (BOA) are confident that the lower valued dollar will persist for the next few years with only minor ups and downs. But others believe the dollar will start to creep upward, maybe by the end of the year, and put a stop to the expected gains in U.S. exports.

For some electronics companies, the dollar's drop is a mixed blessing

The decline in the dollar "is a long-term adjustment to what was a long-term run up in the early 1980s," says BOA senior economist Jeanette Garretty. "Things are coming much closer in balance than what we have seen in the last five years," she adds. Currency stability, however, will not benefit all business segments equally. High tech, says Garretty, will be the main winner. Other industry segments, including agriculture, petroleum and low technology, are not expected to recover in the near term. High tech, many argue, must play the phoenix and resurrect the trade imbalance through import substitution (replacing foreign goods with domestic goods) and export growth.

Because of the weakening dollar, BOA's World Information Services (WIS) is forecasting U.S. exports of high-technology products to more than double within the next 10 years. In 1987, the WIS U.S. Economic Report claims, exports of high-technology products will climb to around $90 billion dollars, up from $72.5 billion in 1986. To meet the growing demand, domestic output will have to rise by as much as 50% over the next 10 years.

But Howard Rosen, research associate at the Institute for International Studies in Washington, D.C., is not too impressed with the WIS forecast, considering the dismal growth high tech has posted in the last few years. "I hope it is a 50% increase," Rosen says. "If not, these [high-tech] guys are really in trouble."

Unlike Garretty, Rosen does not think the dollar drop is a long-term phenomenon. He believes it could start to climb by the end of the year as a result of growing demand for U.S. goods and climbing domestic interest rates brought about by the need for the U.S. to attract foreign capital.

Rosen is quick to point out that, although the dollar has fallen by over

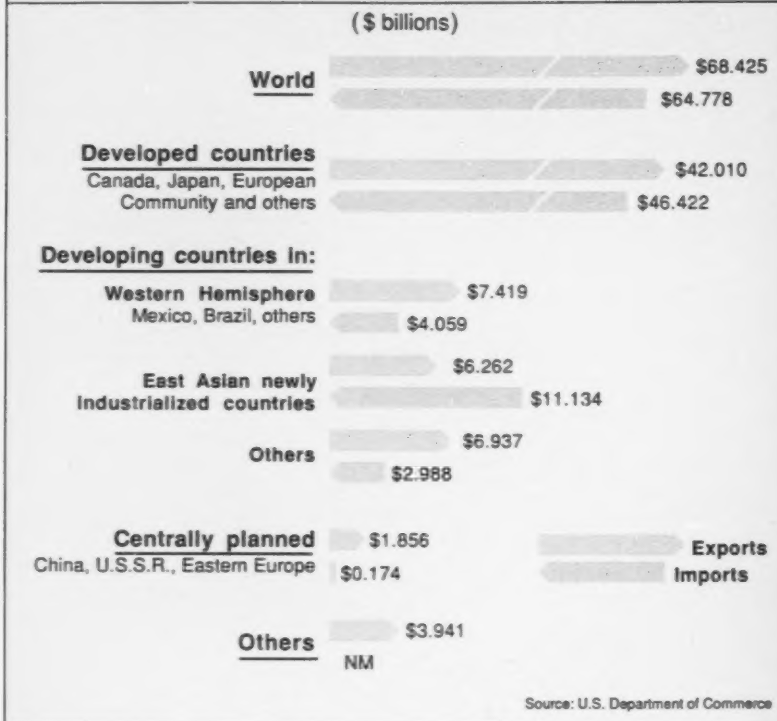
40% in value compared with the Japanese yen and the German D-mark since early 1985, it has barely moved in relation to the currencies of Taiwan, South Korea, Singapore or Hong Kong — known as newly industrialized countries (NICs). Neither has it changed in relation to the Canadian dollar.

In 1985, over 20% of all U.S. high-tech exports, as defined by the Department of Commerce, went to these countries and they were the source of over 25% of America's high-tech imports. Asia's share of total U.S. trade has risen to 32%, up 11% since the mid-70s. In total, the NICs and Canada account for almost one-third of the U.S. merchandise trade. According to Lewenstein at the AEA, the electronics trade balance with Taiwan has gone from a $2.5 billion deficit in 1985 to a $2.9 billion deficit in 1986.

Robert Golden, vice president for finance at Mueller Electric Co., a $5 million maker of electrical test clips and test leads, says he is seeing some improvement in his company's Canadian sales but is not sure whether it is a result of the dollar movement or the company's marketing strategy. About 10% of the Ohio-based company's sales are overseas, with most of that in the European market. Although Golden expects to see some improvement in the European market, there has been no improvement yet, he says.

When the dollar drops, NIC exports become that much more competitive with U.S. products for world market share. All of the major Japanese electronics multinationals have been capitalizing on the exchange-rate differential by shifting production to these countries, and the United States has been doing the same. Japan, however, may have more to gain. Also, when the dollar was high in 1984 and 1985, U.S. high-tech exports became relatively more expensive to NICs and Canada in relation to European and Japanese goods. Canada's imports of high-tech goods from the United States declined by 3% between 1984 and 1985, and East Asian NIC countries dropped by 1.9%.

1985 U.S. high-tech trade by region



Source: U.S. Department of Commerce

There are now some signs of slight movements between the NIC countries and the U.S. dollar, but nothing compared with what has happened with the European Economic Community's (EEC) currencies and the Japanese yen. The Taiwanese dollar dropped 10.5% in relation to the U.S. dollar between February 1985 and January 1987, while the European

The U.S. balance in high-tech trade by segment

($ millions)

	1985			1986		
	Exports	Imports	Balance	Exports	Imports	Balance
Aircraft and parts	$17,535	$4,718	+$12,817	$18,435	$5,781	+$12,654
Communication equipment and electronic components	13,472	30,179	-16,707	14,873	33,495	-18,622
Engines, turbines and parts	3,127	2,980	+147	2,757	3,552	-795
Guided missiles and spacecraft	827	124	+703	664	168	+496
Office computing and accounting machines	15,421	10,901	+4,520	16,096	13,899	+2,197
Ordinance and accessories	714	255	+459	748	359	+389
Professional and scientific instruments	7,134	8,895	-1,761	7,816	10,735	-2,919

Source: U.S. Department of Commerce, Bureau of the Census currencies dropped 40.1%, according to the Federal Reserve Bank of Atlanta's indexes. However, the Canadian dollar dropped only 3% over the same time period and the basket of Asian currencies, excluding Japan, slipped a meager 0.2%.

In order to improve the U.S. trade balance, economists argue, some NICs should revalue their currencies in relation to the U.S. dollar. If they do not, the United States could retaliate by hardening its own protectionist stance. For a country like Taiwan, that ships over 50% of its exports to the United States, keeping its currency overvalued would be economic suicide.

But Data Resources Inc. (DRI), senior economist Sara Johnson does not expect any quick moves by the NIC countries to realign. In the short term, she says, they will keep their currencies tied to the dollar and the United States will try to bring some pressure to raise the value of their currencies. Taiwan, because of its huge current-account surplus, estimated at around 20% of its GNP, is a likely candidate for a revaluation, Johnson says. But others, such as South Korea, with close to a $50 billion foreign debt, might not be appropriate for currency adjustments.

A leveraged economy

Johnson expects the U.S. dollar to remain down for the medium term and expects America's high-tech trade balance to return to surplus in 1987. Total real imports to Korea are expected to grow by 21% while Taiwan's demand for foreign goods will grow by 16% this year, DRI forecasts. The U.S. share of this demand will "increase more than proportionately," Johnson says. Canada's imports, on the other hand, are only expected to grow at 4% in 1987 because of sluggish GNP growth. Similarly, DRI expects West Germany's imports to expand at a 9% clip; Japan's at 7%; Britain's at 7%; and Italy's at 10% for 1987. Most of these countries are showing GNP growth rates lower than the United States for 1987.

While high-tech might pull out of a deficit in 1987, the current account balance is not expected to come into the black anytime in this century, says Johnson. The reason is the highly leveraged U.S. economy — a runaway budget deficit and low levels of corporate and personal saving — coupled with sluggish world economic growth and developing country debt. Comments Johnson: "It is difficult to determine whether or not [the trade deficit] is an insurmountable problem."

The trade and budget deficits are severe but, because the United States has never been in such a position before, it is unclear just how severe. Rosen warns that the United States must start producing budget surpluses by the 1990s in order to pay off its debt, but he sees little chance of this actually happening. "I don't even think this is a long-term turn around in the dollar," he warns.

BOA's Garretty agrees that surpluses are needed and that to ignore the deficit problems will only create serious problems down the road. But BOA is forecasting that manufactured goods trade balance could improve by as much as $200 billion within 10 years, which would put that segment of the current account into surplus. But the problem lies with the growth of the nonmanufactured goods deficit and the services deficit, which included the cost of servicing the growing foreign debt.

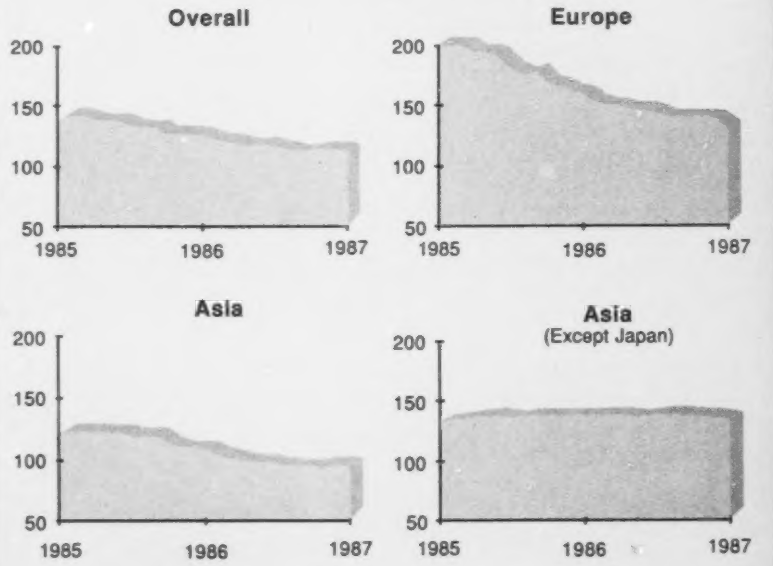
Companies are becoming more adept at operating in the global arena

As for the competitive position of U.S. firms, especially high-tech companies, it is difficult to determine if shifts in market share are caused by structural change in the global market or by changes in exchange rates. More and more, economists argue, it is wrong to focus on a country's trade balance to gauge the health of its industry. With the blossoming of joint ventures, foreign subsidiaries and marketing agreements, companies are becoming less dependent on the health of their country of origin and more adept at operating in the global arena.

Economists Robert Lipsey and Irving Kravis have found that the worldwide market share of U.S. multinational corporations has not changed significantly since 1966, despite the decline in U.S. market share. These companies, they argue, are not dependent on international price differentials for their well-being. Instead, they shift production to the most economical market to ensure they stay competitive. As more companies strike international poses, the health of the U.S. trade balance will come to be less significant to the health of individual corporations. ☐

The decline of the dollar

(Index: 1980 = 100)



Source: Federal Reserve Bank of Atlanta

New challenges for U.S. connector makers

Changing requirements in the computer and electronics industry are changing the way connector makers do business

By Mike Leibowitz

In an age where almost every industry is striving to become more market driven there is one industry — connectors — that wishes it could become less so. During its 40-year history, the U.S. connector industry never had a choice in the matter. A quintessential market-driven business, the sole purpose of connectors is to accommodate the changing requirements of electronic circuitry and systems.

But whereas the U.S. connector industry rode a powerful wave of growth in electronic equipment manufacturing — allowing it to swell at a rate of 20% to 30% annually during the 1970s — today, the wave is gone. Instead, the U.S. equipment market is dictating a new, harsh market reality to connector vendors. And, in true tradition, the connector industry is adapting to it.

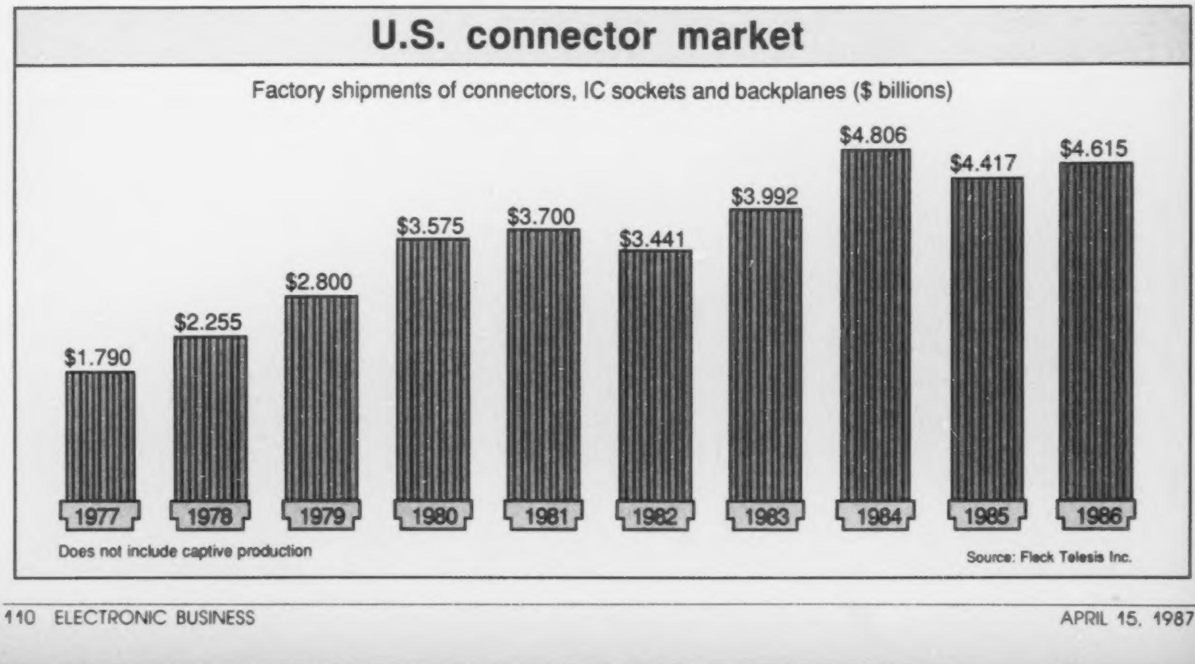
The past two years have been particularly difficult ones for the $4.62 billion U.S. connector industry. After suddenly dropping 8.1% in 1985, a small level of growth — 4.5% — has returned to the U.S. connector industry in 1986, according to Fleck Telesis, a Huntington Beach, Calif., connector market analysis firm. But the gloomy news is that the present situation is not expected to get much better.

The U.S. equipment market is dictating a new, harsh reality to connector vendors

"I do not believe we'll ever see the heyday of 25% and 30% expansions ever again," says Fleck Telesis' president, Kenneth A. Fleck. During the next five years, Fleck projects a mere 5.5% average annual growth rate for the U.S. connector industry. According to Fleck, the connector industry must reconcile itself to a future of low growth levels.

Others in the industry are a little more optimistic. While agreeing the heyday has past, Richard Evans, marketing operations director for Minnesota Mining and Manufacturing (3M) Co.'s Electronic Products Division, says that a more reasonable average growth projection is 8% to 10% annually through 1991. "I'm not in the doom and gloom camp," says Evans.

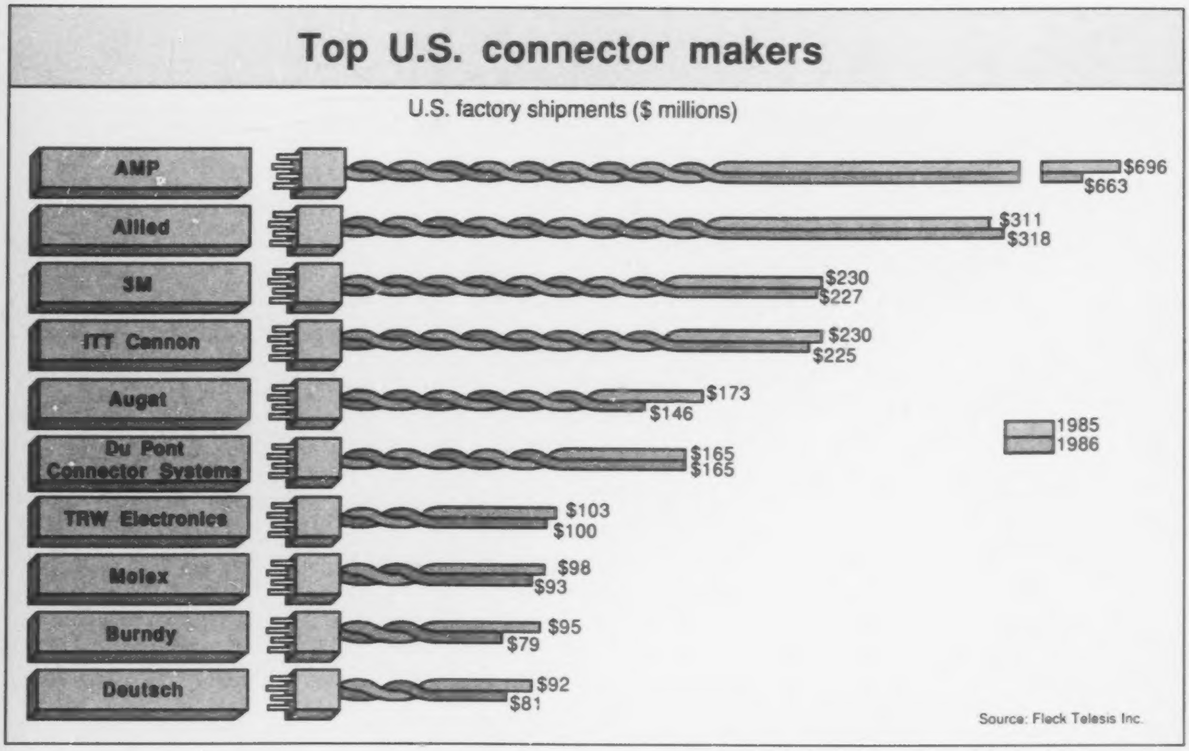
Vendors and analysts give a couple of reasons for the low growth projections. Some of the blame is placed on the industry's overcapacity and a temporary slowdown in the production of certain end products such as computers, which the connector industry re-


U.S. connector market

Factory shipments of connectors, IC sockets and backplanes ($ billions)

Does not include captive production

Source: Fleck Telesis Inc.


Top U.S. connector makers

U.S. factory shipments ($ millions)

Source: Fleck Telesis Inc.

lied on for much of its growth during the 1970s.

But, far more catastrophic, many believe, are the permanent market losses occurring from the exodus of U.S. manufacturing overseas. This exodus is a result of foreign equipment manufacturers taking market share from U.S. original equipment manufacturers (OEMs) and from American firms moving their manufacturing offshore. Those firms assembling overseas might initially continue buying from U.S. vendors, says William Nuckols, vice president of Burndy Corp., but they ultimately switch to local sources. "To the extent that production of the end product is overseas, a net loss [occurs] to the U.S. connector market."

Foreign competition

Many also cite a relatively new phenomena in the U.S. connector market: competition from foreign connector firms. Virtually nonexistent five years ago, the presence of Far Eastern connector vendors has increased to capture 5.7% of U.S. connector sales in 1986, according to Fleck Telesis. Besides taking market share, these foreign vendors have severely depressed prices for a number of commodity connectors. "The only thing the Japanese or Taiwanese have to offer is a cheaper price," says analyst Fleck.

A case in point is the popular D subminiature connector which is used on terminals and personal computers. The connector sold for over $1 three years ago, but last year, Far Eastern firms bid the price down to 20 cents. U.S. firms managed to keep 90% of the D-subminiature connector business, according to Fleck, but only by matching the 20 cent prices and forsaking profits. Fleck predicts that over the next five years foreign connector firms will continue their efforts to buy into the U.S. market, doubling their overall stake in the U.S. connector market to 10.8% by 1991.

> Some connector vendors have responded to the new market conditions by following the business as it moves offshore

Some connector vendors have responded to the new market conditions by following the business as it moves offshore. In the past five years, five U.S. companies out of the top 10 have opened new plants overseas, and today, 11 of the top 20 U.S. connector firms have foreign manufacturing operations. Recently, many of these firms have seen very strong growth, partly due to a decrease in the value of the dollar versus other currencies. AMP Inc., for example, saw a 36% increase in its foreign sales during 1986, while Molex Inc. saw their foreign sales rise 27%. Both AMP and Molex now make at least 50% of their sales in overseas markets.

But the most fundamental response to the market slowdown is an industry-wide consolidation. Vendors are merging with, and acquiring, other connector firms in order to pool resources, broaden product portfolios, and move into fast growth segments. According to analyst Fleck, six out of the industry's top 20 firms were involved in a merger or acquisition in the past five years. "The big will get bigger and the strong will get stronger," says Fleck. In the future, "a lot of firms will still be in existence, but they will be under one identity."

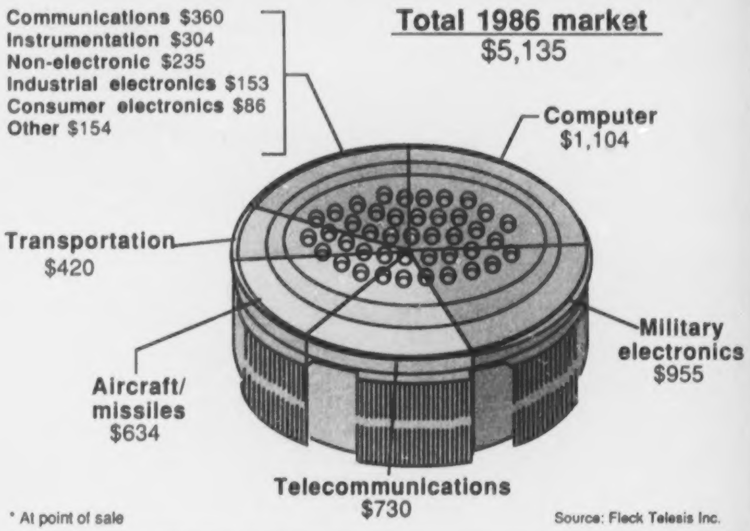
3M, for example, acquired six small specialty connector manufacturers during 1986, increasing their participation in fast-growing product areas. The acquisition of Chabin Corp. now makes 3M a supplier of high-frequency transmission line assemblies, which 3M expects will grow at a rate of 10% to 12% a year. Its acquisition of Symbex Corp. puts 3M in the business of molded cable assemblies, another high growth area. Dorran-Photonics, which 3M also acquired in 1986 gives the company its first fiber-optic product line. “[The acquisitions] either give us a broader product line in an area we were already in, or they take us in a completely brand new direction,” says 3M's Evans.

Acquisitions very clearly will continue as a growth strategy for 3M. Evans says that it is “one of the ways that 3M can get back to healthy double-digit growth.” He expects 3M to average 12% to 15% annual growth in connectors over the next five years.

While the strategy for many major firms is to further entrench themselves through acquisitions, others are pulling out of the business. Allied-Signal Inc., a $11.8 billion conglomerate, has now put up for sale the four companies that it acquired to become the second largest connector supplier: Amphenol, Bendix, Spectrastrip and Underwriter Safety Devices. Comments one vendor, who did not wish to be indentified: “This should tell you something of how some companies view the connector business.”

Connector consumption by market

1986 U.S. consumption of connectors, IC sockets, and backplanes by market segment* ($ millions)



* At point of sale

Source: Fleck Telesis Inc.

Choosy OEMs

Companies that remain in the connector business are further encouraged to consolidate due to many customers' desire to deal with fewer vendors. OEMs are reducing the number of connector vendors they do business with; and keeping only those that provide the broadest lines, highest quality and best delivery performance. “Instead of having 15 or 20 [connector vendors], they are, right now, paring down to five or six, and eventually will pare down to three or four,” says Kerry Krafthefer, Molex's Datacom Division president.

For example, since 1983, Apple Computer Inc. has terminated business with one-third of its connector vendors. Consequently, Apple finds that they receive better service from those remaining vendors. “Instead of taking leverage and spreading it across multiple vendors we take that leverage and apply it to a few,” says James Bilodeau, Apple's materials manager.

At Hewlett-Packard Co., Daniel A. Bechtel, director of corporate materials, says that HP is actively cutting connector vendors while attempting to reduce the number of different connector types in use. “Our goal is deal with probably two, maybe three [vendors] for any one major series of connectors.” About vendors that stay on his list, Bechtel says: “They've got to perform. Basically, they've got to perform.”

Consequently, connector manufacturers now voice a commitment to service with a born-again fervor. “Our industry has had a horrible, horrible reputation over the years for service,” says Fuller Atkinson, vice president and general manager of TRW Inc.'s Connector Components Division. “We had a tendency to get away from very basic principles. Our job is to service our customers and I think we lost sight of that.”

> The key strategy to improving service is to improve manufacturing, vendors say

Improving quality

The key strategy to improving service is to improve manufacturing. Many vendors have installed statistical process control (SPC) systems which tightly monitor and control the manufacturing process from beginning to end, improving quality, reducing scrap, and assuring a continuous flow of product off the line. SPC lowers the number of defective parts reaching customers and reduces the likelihood of missed delivery commitments.

Virtually all of the top 20 vendors today offer just-in-time (JIT) service to some major customers; and most vendors expect to expand their JIT capabilities through 1987. Being able to deliver parts for just-in-time manufacturing does not only benefit JIT customers, vendors say, but JIT improves the overall ability to produce quality products on time; the benefits of JIT spill over into the entire customer base.

Major customers have seen a difference in the service level of connector manufacturers. “They have better deliveries, shorter leadtimes, and their quality has improved,” says Hewlett-Packard's Bechtel. “We're seeing progress.” Apple's Bilodeau agrees, “Those vendors that we now are dealing with give us better quality and much better service than they did five years ago. They cater to our needs a lot better.”

But other customers are waiting for more improvement. James Noll, director for material at Northrop Corp.'s Defense Systems Division says that although the quality of connectors from his 11 vendors has improved, large connector vendors still lack the flexibility to provide “specials,” or slightly modified standard products, in a hurry. His division purchased $3.5 million in connectors last year, but Noll reports, "They are still a pretty independent group of people — the [long] leadtimes pretty well stick."

William Phipps, who supervises the procurement of approximately $750,000 in commercial and military-grade connectors for E-Systems Inc., still suffers from connector manufacturers' missed delivery promises. "Just finding somebody that delivers when they say is tough," he explains. Phipps says that getting reliable connector deliveries is harder than for most other products. "Someone who lives by their contractual commitments — that's rare in the connector industry."

Connector manufacturers say industrial distribution has become more important to them as a way of providing good service to many smaller accounts. Distribution is now 26.7% of the U.S. connector business, from 18% 10 years ago, according to Fleck Telesis. But distributors complain that despite fancy talk, connector manufacturers often do not provide them with the necessary level of technical sales assistance to do their job.

Role of distribution

"Few vendors truly understand the role of the distributor," says Kenneth Block, vice president for marketing/product marketing of No. 1 connector distributor, Time Electronics, a division of Avnet Inc. According to Block, some vendors view distributors as "customers" and expect them to do all the sales work alone. This, he argues, is wrong. "We are a partner."

Many manufacturers form partnerships with major customers to develop leading-edge connectors

Block says that for the most part, vendors that are financially healthy are either increasing their support or continuing reasonable distribution support levels. The less prosperous suppliers, however, have reduced their support. "While they may preach the importance of distribution, they are in survival mode."

Although the market for connectors has slowed, electronics technology has not. Instead, advances have created a precipitous need for new types of connectors and surface mount versions of existing connectors. Unfortunately, this calls for considerable expenditures for product development and tooling at a time when connector vendors can least afford it.

High-density and high pin-count packages require vendors to develop equipment for manufacturing at far tighter tolerances than before. They also require experimenting with new materials that can withstand the stresses of surface mounting without the slightest distortion. And with rising signal frequencies of electronic circuitry and systems, the design of the contact becomes critical. Connector designers must avoid even slight contact discontinuities that could create circuit problems from the reflection of signals.

"For new technology, it's not just a matter of developing a new metal-bashing tool," says Nicholas Pearne, the director of BPA Ltd., a packaging and integration consulting firm of Cold Springs Harbor, N.Y. "You really need a fundamentally different approach."

Firms have targeted the fastest growing market areas as the ones in which to commit internal product development resources. The industry leader, AMP, is focusing its efforts on developing connectors for local area networks, fiber-optic connectors and high-density connectors. Augat Inc. is emphasizing connectors for the automotive and telecommunications markets. TRW is concentrating on developing high-density sockets for next-generation IC packages.

But the rate at which many new products emerge is likely to disappoint customers which already complained that the development of new connectors lags the rest of the electronics industry. The problem in leading-edge connector development is an uncertain return on investment. Vendors now realize that tooling up for leading-edge connectors in advance of demand is "a very risky strategy to follow," according to packaging consultant Pearne. Connector manufacturers, unlike semiconductor makers, typically have little ability to predict which connectors will become widely accepted. This makes it virtually impossible for them to gauge which products they should develop for a future market. For example, "a lot of them made a commitment to JEDEC J-leaded packages," says Pearne. "They are now wondering whether those will ever be of any use to anyone."

Indeed, many manufacturers frequently form partnerships with major customers to develop leading-edge connectors. This does two things: it guarantees that the vendor will see at least nominal business for the product, and it gives the product a head start toward becoming an industry standard. The burden for creating advanced connectors therefore falls on the customer. "Who's been sorting out IBM's problems for high pin-count zero-insertion force connectors?" asks Pearne. "The answer is: IBM. Where did DIN connectors come from? Siemens — because they needed them. It tends to be the OEM, who eventually says, 'I'm going to realize the benefit of this, I'll make it happen.'" Pearne says it will be the systems houses that propel new product development. "It has got to be the customer that says what he needs."

Connector makers are waiting for their customers to make a commitment to surface mount technology

The same problem applies to surface mount connectors. "Connectors are one of the last components to get [vendor] attention from the surface mount standpoint," says 3M's Evans. One reason, says Evans, is the considerable effort required to develop a connector that "people grab ahold of, pull on and push against, and wiggle." Another reason, is that vendors are waiting for customers to make a commitment to the technology. Today, 5% or less of all printed circuit boards are surface mounted, says James Marley, president of AMP.

3M illustrates the problem many vendors face in developing surface mount products. They have developed internal capability to design and build surface mount connectors and have sampled 25 customers, but they are working with only six customers so far, according to 3M's Evans. In the meantime, 3M has introduced a surface-mount compatible product line that utilizes a through-hole pin with a solder doughnut on it. This interim step allows the part to be soldered at the same time as the other components. But as for their long-term surface mount product plans, "We're looking for OEMs so that we can continue developing [surface mount] products for the market," says Evans. □

Design and engineering: Where the dollars are headed

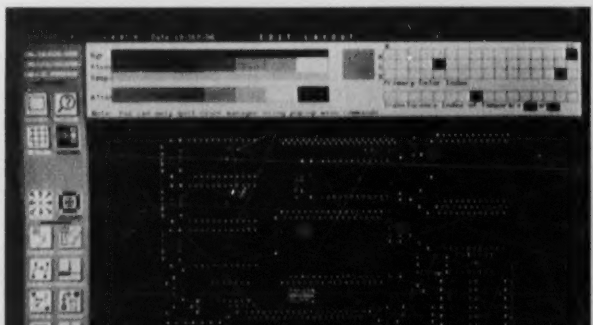
CAD systems and engineering applications are underway. The managers control the funds

The automation of the electronic design and engineering process is receiving tremendous investment and attention. The addition of the engineering workstation to the engineering activity has transformed the entire computer-aided design and engineering (CAD/CAE) environment.

The workstation and accompanying software and peripherals have meant that electronics executives are faced with capital investment decisions that are vital to a company's strategic future. In order to understand the current attitudes toward the design and engineering process, ELECTRONIC BUSINESS in conjunction with Coopers & Lybrand undertook a sweeping survey of the design and engineering universe. The results of the survey are contained in the following special report. The report includes the survey's results along with an accompanying analysis by Coopers & Lybrand.

The survey was mailed out to 1,500 presidents, vice presidents and chairmen, and to 1,500 vice presidents for engineering, directors of engineering, engineering managers and chief engineers from ELECTRONIC BUSINESS' circulation list. We received 230 responses, with 100 letters returned to sender, that left us with an 8% response rate. The answers that we compiled from these responses have a 95% confidence level of accuracy to ±3%.

ERIC LUNDQUIST



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Coopers & Lybrand

Electronic Business

Design automation: A strategic necessity

Most electronics and computer companies are automating their design process. But chief executives must become more involved

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By Irvin Krause and Cheryl R. Suchors

The need for electronics companies to move new products into the market faster grows more urgent daily. At the same time, the majority of the cost content of a quality electronics product is determined by its design. Companies whose design and engineering departments do not use computers effectively or whose departments are not properly integrated into the manufacturing and marketing operations as part of an overall computer integrated manufacturing (CIM) process will not be able to compete in the global marketplace.

Most electronics companies have begun to automate the design and engineering function — but they are strolling rather than sprinting toward full automation. Despite the fact that strategic planning and major capital investments are involved, chief executives are not yet taking the initiative they should to implement CIM on a company-wide basis; many executives are untutored in this area of automation. Unless executives guide the process of automation within their companies, each department will purchase equipment that meets only its own needs. Isolated pockets of automation will result and the company will forfeit the strategic momentum a CIM environment can provide.

Surprisingly, smaller companies, perhaps because of their greater vulnerability to competitive actions, have moved into this area of CIM more aggressively and with more chief executive initiative-taking than larger electronics firms.

Adding to the slow penetration of CIM in design and engineering is the fact that the traditional measure of return on investment (ROI) is one of the hardest to use to justify the expense of automation. Most of the investments in automating design and engineering departments in companies of all sizes have been made in the labor-intensive areas of artwork preparation and schematic capture. The chief benefit in these areas is savings in direct labor costs.

Automation of design rules, for example, means fewer engineering changes once the product is released to manufacturing. The manufacturing operation runs more smoothly and efficiently and the product gets to market sooner. Although major strategic benefits are realized, these results are harder both to measure and attribute to the automation of the design and engineering department.

We expect to see continued corporate investment and greater penetration of CIM into the labor-intensive aspects of the design and engineering process. We believe companies will also broaden the usage of workstations to engineering applications, such as design rules, as companies better learn how to quantify the strategic importance of CIM to this function.

However, for electronics firms to win in the race to worldwide markets, they will have to take longer and more far-reaching strides in automation. Companies will need to operate on a project management basis enabling the design, manufacturing, and marketing functions to operate simultaneously rather than in sequence, as they do now.

Projects carried out in this kind of work environment could cut product leadtimes dramatically. The project-oriented environment requires various departments in the organization to supply and to share information accurately and within the times required by project management systems. Designers will require cost and projected cost information from the manufacturing or financial departments. Designers, in turn, must supply production and marketing personnel with staged partial designs in addition to completed designs. Such high-level integration can occur only where the design and engineering department is automated and where there is company-wide implementation of CIM.

Engineers will continue to press for automated tools to improve the quality and ease of their work. Only top management can ensure that the automation of the design and engineering department enhances productivity throughout the firm.

Every survey respondent with more than

$50 million in revenue has indeed begun to automate the design and engineering function. Almost all (90%) of the companies between $20 million and $50 million in sales are also using computers for design work.

Companies under $20 million in sales report that 38% have yet to buy their first workstation. Even so, the clear majority of even the smallest companies in the survey have already taken some steps on the road to CIM.

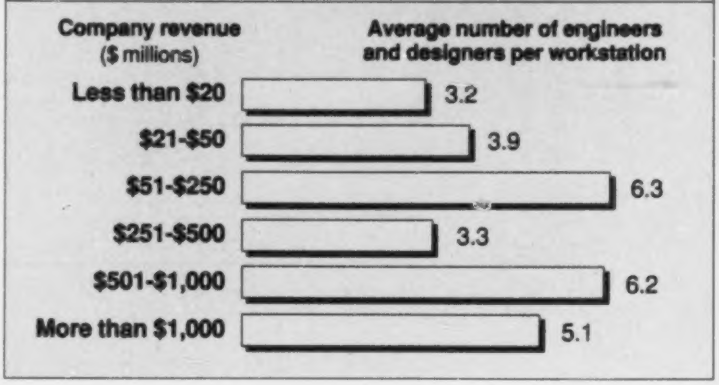
These impressive penetration percentages conjure up images of equally impressive investment figures. Yet only a small portion of the companies have invested more than $500,000 in any one area of the design process. Even though you might expect that most billion-dollar electronics firms would spend over a million dollars in 1987 in a number of areas of the design process, this is not the case.

Despite lower capital investments in equipment, the smallest companies are further ahead in terms of penetration of automation into the design and engineering function. The largest companies in the survey reported that they own one workstation for every five to six engineers. The smallest companies have significantly fewer engineers sharing equipment — three to four per workstation.

Even though less absolute investment is required for the smaller engineering and design departments of companies with less than $20 million in sales, these results are surprising. Smaller companies may well be using equipment availability to help attract and retain the engineering talent they need to compete against the deeper pockets and broader resources of larger competitors.

One explanation behind low investment levels in general is that chief executives are

Penetration of CIM into design and engineering departments



What has automating the design and engineering process accomplished?

	Size of company ($ millions)					
	Less than $20	$20 - $50	$51 - $250	$251 - $500	$501 - $1,000	More than $1,000
Achieved faster time to market	68%	61%	50%	82%	88%	80%
Met ROI expectation	53%	45%	53%	43%	43%	56%
Improved design productivity	78%	68%	67%	100%	88%	88%
Improved manufacturing quality	65%	65%	76%	56%	100%	79%

How do electronics companies justify automating the design process?

	Most important justification	Second most important justification	Third most important justification	Total respondents marking each category
Faster time to market	14.7%	11.4%	3.9%	30%
Traditional return on investment	10.9%	4.2%	5.9%	21%
Improved manufacturing quality	6.0%	11.0%	8.0%	25%
Can't design product without it	3.9%	2.8%	2.3%	9%
Shortage of designers	3.4%	3.4%	5.2%	12%
Other	2.1%	0.3%	0.6%	3%

Only top management can ensure that the automation of the design and engineering department enhances productivity throughout the firm

not initiating it. The initiative for automating the design process in reponding companies of all sizes is coming primarily from the engineering department itself — not from senior management or from a company-wide plan to implement CIM. This was the case with the initial computerization of materials management and financial systems.

Only in the smallest companies does the chief executive or president take the initiative. And the push to automate is implemented through a formal CIM plan only in the second smallest grouping of companies, those between $20 million and $50 million in sales, not in the larger companies more frequently associated with the rigors of formal planning. In larger companies, the second most influential source spurring investment in automation of design and engineering comes from outside of the company — competition.

Although the presidents do not usually initiate the purchase of workstations, they do control the system's purchase. Fifty-one percent of the responding companies reported that the president or chief executive had to approve the decision to automate. Senior executives, in all of the companies except those with over $1 billion in revenue, were involved in automating their engineering and design departments — but at the end of the process rather than the beginning. Top management seems to be more reactive than proactive toward the process of automation.

The largest companies in the survey are certain that they are doing at least as well or better than their competitors in automating the design process. Only 12% of the companies worth between $500 million and $1 billion thought that they were behind the competition; none of the companies worth over $1 billion thought so.

In comparison, 42% of the companies worth under $20 million believed that they lagged the competition in automation. More than a third of those worth between $20 million and $50 million felt the same. This perception may well be the driving force behind these groups' executive-level initiatives toward automation and the resulting higher penetration levels. Smaller companies are, in fact, beating their larger competitors in providing their engineers with better access to equipment.

Are managers satisfied?

Ninety percent of the respondents to our survey on automating the design and engineering function said they would do it again.

Across the board, management of electronics companies cited "faster time to market" as the most important reason for justifying the purchase of workstations and other equipment. The second most important reason was the traditional ROI ratio.

Most respondents were confident that automation had shortened their time to market, especially in the companies having over $250 million in sales. The majority had also improved their design productivity and their manufacturing quality, key factors to successful operations and both rated highly as reasons to automate.

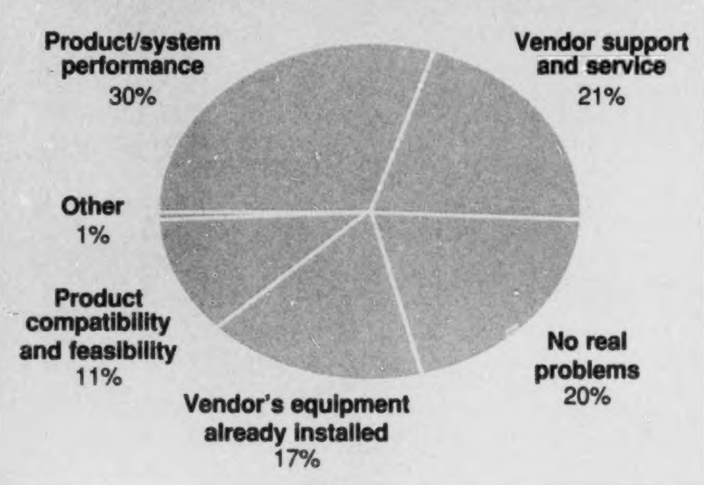
Automation's ability to meet ROI projections turned out to be closer to a 50-50 proposition. And, even though ROI analyses are appropriate to gauge the importance of an automation investment, the analyses are only as good as the cost/benefit data used.

Present cost accounting methods were developed when industry was labor-intensive and direct labor was the dominant component of product cost. Today, most electronics companies experience direct labor costs that are 5% to 15% of product costs. The costs of materials, overhead and indirect labor are more important now. It is the latter two nondirect costs that managers have difficulty identifying and quantifying — this cripples ROI analysis of automation. *(Continued)*

Who prompted electronics companies to automate the design process?

	Most influential	Second most influential	Third most influential	Total respondents marking each category
Engineering department request	28.9%	5.7%	3.4%	38%
Manufacturing department request	9.2%	3.8%	–	13%
President/CEO directive	3.9%	8.7%	2.4%	15%
Part of CIM plan	3.8%	2.5%	2.7%	9%
Other	3.2%	0.8%	–	4%
Competition using it	3.1%	5.0%	5.9%	14%
Customer request	0.7%	0.4%	0.9%	2%
Marketing department request	–	3.2%	1.8%	5%

Why workstation users would buy again from their current vendors



To provide the correct data for ROI analysis, companies must first diagram the flow of work and data in any part of the organization affected by the proposed automation ROI system. If this diagram is not accurate, the foundation for the cost and benefit analysis begins to crumble.

Once the work and data flow are understood, cost-driving sources are identified. One cost driver is when engineering design errors are discovered after the design is released to manufacturing.

A design error would trigger the performance of a number of tasks: inspecting or testing parts; preparing failure reports; requesting an engineering change; modifying the design, the bill of materials and routings; changing tooling; adjusting purchasing specifications and so on. Each activity would be identified, assigned to a cost center, and its costs quantified.

This is the only way accurate cost and benefit information can be included in the ROI analysis of the proposed workstation. The alternative is an analysis which focuses on direct labor costs and benefits and ignores nondirect costs in an industry where overhead and indirect labor costs are key.

Vendor performance

Our survey companies' current vendors of automation equipment would be selected again for additional purchases by 86% of the respondents. They said their chief reasons for staying with the current vendors are: product performance, vendor service and support, and the lack of significant problems with the equipment in place. The fourth most frequent reason given is that the vendors's equipment was already in place, demonstrating the importance of an installed base to vendors.

The three biggest vendors that our respondents used were Apollo, DEC and IBM. In the companies with less than $250 million in revenue, IBM took the lead. However, market leadership switched to DEC with companies having sales greater than $500 million. And, in the midrange, Apollo became a major player, ultimately matching or beating IBM's market share.

The good news for vendors is that the biggest problem electronics companies are having in automating the design and engineerng function is lack of funding, not lack of vendor support. This suggests that, as the electronics industry works its way out of the slump of 1985 and 1986, sales for workstations should rise significantly. Vendors should also take note that the second largest problem cited by users — that equipment did not perform as promised — suggests room for improvement. ☐

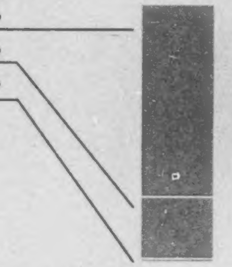
How did electronics companies rate their biggest problems so far in automating the design process?

	Biggest problem	Second biggest problem	Third biggest problem	Total respondents marking each category
Lack of funding	12.6%	4.0%	3.4%	20%
Equipment did not perform as promised	9.7%	4.3%	3.0%	17%
Employee retraining	9.0%	7.5%	5.5%	22%
How to measure designer's performance	5.6%	2.9%	3.5%	12%
Other	4.4%	1.0%	0.6%	6%
No problems	2.8%	0.4%	0.8%	4%
Manager training	2.2%	4.7%	3.1%	10%
Lack of vendor support	1.5%	5.1%	2.4%	9%

Design Automation Survey

Has your company invested in automating the product design process?

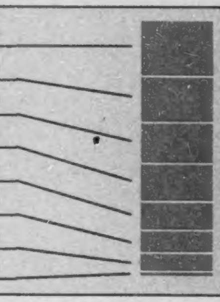
Yes	75%
No	24%
No response	1%



Three quarters of the companies responding have invested in automating the design process.

If yes, check categories in which your company has invested. If no, check the categories in which you anticipate investment:

Schematic capture	23%
Circuit board layout/artwork	18%
Simulation	16%
Circuit design/logic	15%
Layout/timing verification	11%
Electrical design rules	9%
Generation of test patterns	6%
Other	2%



Much of the investment has gone into schematic capture and circuit board layout rather than the more engineering-intensive activities of simulation, verification and test.

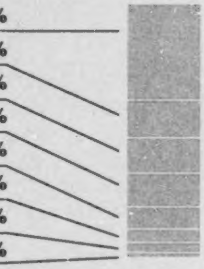
How much has your company invested in automating each part of the design process, and how much does your company anticipate to invest in calendar 1987?

Current investment	$1,000 – $5,999	$6,000 – $50,000	$50,001 – $500,000	$500,001 – $1 million	Over $1 million
Schematic capture	27%	40%	24%	2%	7%
Circuit board layout/artwork	21%	27%	32%	7%	13%
Simulation	21%	29%	35%	6%	9%
Circuit design/logic	23%	27%	37%	4%	9%
Layout/timing verification	18%	25%	41%	6%	10%
Electrical design rules	18%	28%	38%	6%	10%
Generation of test patterns	21%	33%	15%	15%	16%
Other	16%	32%	26%	16%	10%
Expected 1987 investment					
Schematic capture	34%	45%	18%	0%	3%
Circuit board layout/artwork	31%	33%	29%	3%	4%
Simulation	23%	53%	18%	1%	5%
Circuit design/logic	23%	42%	27%	3%	5%
Layout/timing verification	33%	40%	19%	2%	6%
Electrical design rules	24%	31%	34%	3%	8%
Generation of test patterns	24%	36%	24%	8%	8%
Other	25%	40%	40%	0%	0%

As system cost declines, investment activity is projected to pick up dramatically at the low end while leveling off at the high end.

What was the most important factor which prompted your company to automate the design process?

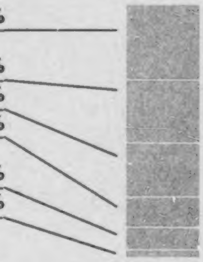
Engineering dept. request	38%
President/CEO directive	15%
Competition using it	14%
Manufacturing dept. request	13%
Part of CIM plan	9%
Marketing dept. request	5%
Other	4%
Customer request	2%



The initiative to automate is still coming from the engineering department. Upper level management remains the second most important influence in starting the automation process.

What was the most important factor in justifying these investments?

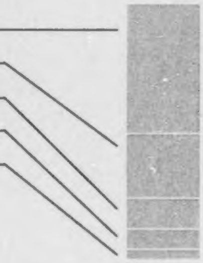
Faster time to market	30%
Improved manufacturing quality	25%
Traditional ROI methods	21%
Shortage of skilled designers	12%
Can't design product without it	9%
Other	3%



The need to speed the new product development process outpaces all other reasons for justifying the design automation investment.

Who approved the decision to automate?

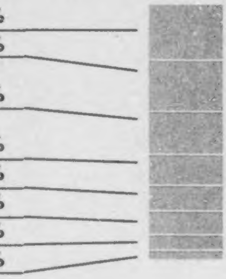
President/CEO	51%
Chief engineer	25%
Operations manager	12%
Chief financial officer	8%
Other	4%



The boss still controls the purse strings. Presidents, chief executives and chief engineers are the gatekeepers to design systems spending.

What has been the biggest problem so far in automating the design process?

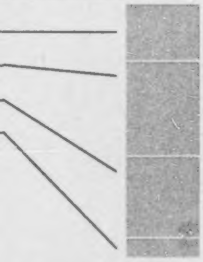
Employee retraining	22%
Lack of funding	20%
Equipment did not perform as promised	17%
How to measure designer's performance	12%
Manager retraining	10%
Lack of vendor support	9%
Other	6%
No problems	4%



Employee retraining has proven to be more of a problem in automating the design process than access to funds.

Do you think your company is more, or less, automated than your competition?

More	23%
Same	37%
Less	32%
No opinion	8%



On the whole, respondents did not feel they were clearly in the lead or significantly behind their competition in the race to automate.

Approximately how many engineers and designers does your company have?

The average was 205 engineers and designers.

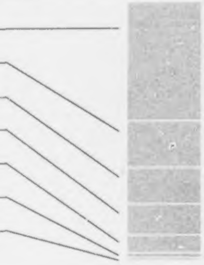
Approximately how many design/engineering workstations does your company have?

The average was 54 workstations.

On average, companies have a 1:4 ratio of workstations to engineers and designers.

What vendors make the workstations that you use? (Check all which apply.)

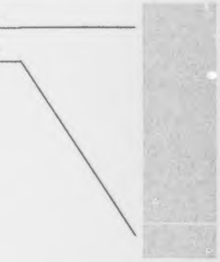
IBM	46%
DEC	18%
Apollo	14%
Hewlett-Packard	12%
Sun Microsystems	7%
MASSCOMP	2%
Silicon Graphics	1%



IBM remains the leading workstation, with DEC and Apollo in the second and third positions.

Would you buy again from the same vendors?

Yes	86%
No	14%



Most respondents would go back to the same vendor they had dealt with before.

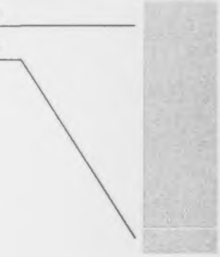
What have been your results in automating the design process?

	Yes	No	NA
Met ROI expectations	52%	29%	19%
Improved productivity	78%	12%	10%
Achieved faster time to market	68%	15%	17%
Improved manufacturing quality	71%	16%	13%
Other	52%	44%	4%

The respondents have been pleased so far with the results of their automation efforts.

If you had to do it over, do you believe your company would choose to automate the design process?

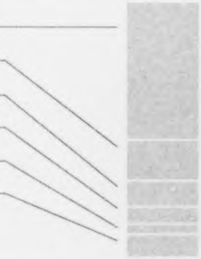
Yes	90%
No	10%



An overwhelming number of respondents are convinced that automation was a wise move.

Your company's annual revenue is approximately:

Under $20 million	54%
$20 million – $50 million	16%
$50 million – $250 million	10%
$250 million – $500 million	7%
$500 million – $1 billion	4%
Over $1 billion	9%



The respondents came from a broad range of small, medium and large size companies.

Your company deals in which of the following? (Check all which apply.)

Industrial-based computer systems	13%
Components	11%
Communications	10%
Microcomputers	10%
Capital equipment	9%
Semiconductors	8%
Military	7%
Minicomputers	7%
Peripherals	7%
Office equipment	5%
Mainframe computers	2%
Distribution	1%
Other	10%

The respondents were from a wide spectrum of computer and component companies in the electronics industry.

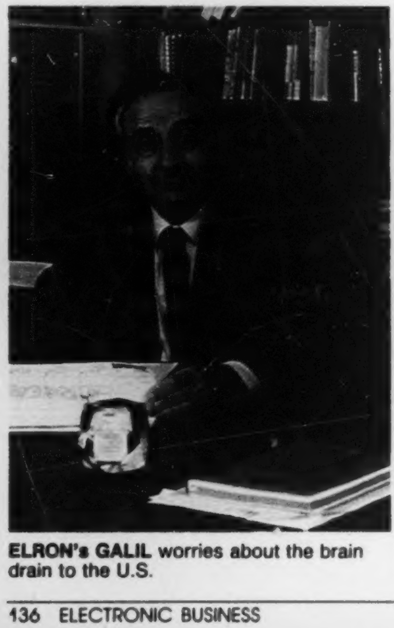
Defense drives Israel's electronics industry

With government support, Israel is emerging as a major high-tech arms dealer on the world market

It is now 20 years since Israel annihilated the air forces of Egypt and its Arab neighbors at the start of the Six Day War. By the end of that day — June 5, 1967 — the Israelis' French-built Mirage III fighter-bombers knocked out 374 enemy planes for the loss of only 19 of their own.

But, General Charles de Gaulle, France's President, was bent on winning Arab allies. Just as the Israelis were celebrating their victory, de Gaulle banned future deliveries of Mirages to Israel. "De Gaulle's embargo taught us a tough lesson," recalls General Dan Tolkowsky, a former commander in chief of the Israeli air force and now the country's leading venture capitalist. "We learned we could not afford to depend on foreign technology. And that's how Israel was driven to develop its own high-tech industries."

Today Israel makes many of its own warplanes and much of its avionics. The latest jet fighter, the Lavi, has been hailed by U.S. experts as one of the most advanced — but also the costliest — in the world. Israel has certainly not slammed the door on foreign suppliers. "But what matters is that we have mastered state-of-the-art technologies," says Uzia Galil, president of Elron Electronics Industries Ltd., a diversified electronics holding company. "U.S. and European high-tech companies today prefer to sell us whatever we need because they know we can always go ahead and make it ourselves."



ELRON's GALIL worries about the brain drain to the U.S.

As a result, Israel today boasts a number of world leaders in electronics such as Elbit Computers Ltd. in defense systems, Elscint Ltd. in diagnostic medical imaging, Fibronics Ltd. in fiber-optic communications, Laser Industries Ltd. in laser surgery, Optrotech Ltd. and Orbot Systems Ltd. in vision systems for inspecting printed circuit boards (PCBs) and Scitex Corporation Ltd. in image processing.

Israel today boasts a number of world leaders in electronics

For all these companies the United States is the major sales outlet. And many of the managers and engineers who work in them are often graduates of both Israeli universities, such as Technion, and of the Massachusetts Institute of Technology or Stanford. "There's a genuine cross-culture between U.S. and Israeli electronics," remarks Elron's Galil.

Spurred by its harsh experience when France withheld warplanes during the Six Day War, Israel has strongly focused its electronics industry on meeting the country's defense needs. These requirements often match those of the United States.

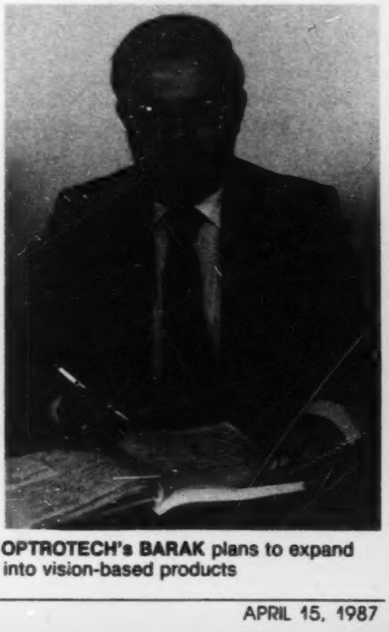
Elbit, the defense systems manufacturer, now earns one-third of its revenue in the United States, and half its sales backlog lies there. It has supplied weapons delivery and navigation systems for the General Dynamics F-16 warplane and is now upgrading the avionics of the McDonnell Douglas F-4 Phantom aircraft. The Israeli company's digital tank fire control system has been adapted for the American M-48 and M-46 and, in a simplified version, for the M-41, M-47 and Sherman tanks.

Aharon Amit, Elbit's vice-president of marketing, says: "Now that the Israeli government has cut back its spending on defense, overseas sales are becoming even more important than ever."

Israel Aircraft Industries Ltd. (IAI) is also a major supplier of high-tech products to both the Israeli and U.S. armed forces. These include the Mini-Remotely Piloted Vehicles (MIRPV), developed jointly by IAI's subsidiary Tamam Precision Instruments with Tadiran Printed Circuits Ltd. The Mastiff MIRPVs have been awarded contracts by the U.S. Army and Navy following the successful use of this drone by the Israeli armed forces in Lebanon.

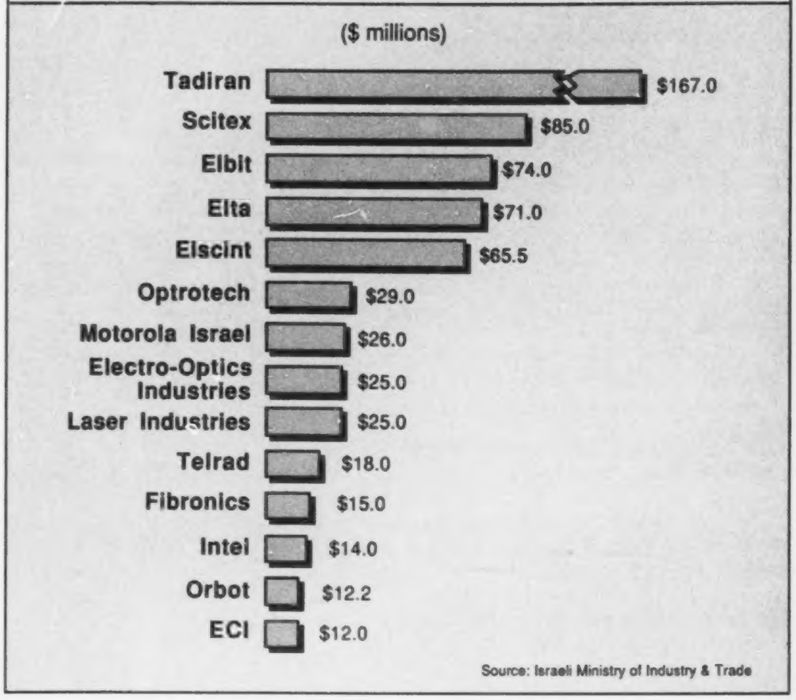
MBT Weapons Systems, another IAI offshoot which is famous for the Gabriel missile family, works closely with U.S. military contractors. Noam Zafrir, international marketing manager at MBT, says: "The Americans are particularly interested in our work because most of our engineers serve regularly in Israeli military reserve units. That means we get excellent input about how our products perform under battle conditions."

State funded research and development (R&D) play key roles in encouraging new electronics ventures in Israel. "In fact, we are the real venture capitalists here," says Yigal Erlich, chief scientist and head of industrial research and development at the Ministry of Industry and Trade. State aid, which will total $80 million for the current fiscal year, has launched a



OPTROTECH's BARAK plans to expand into vision-based products

Sales of leading Israeli electronic manufacturers in 1986



Source: Israeli Ministry of Industry & Trade

host of companies, both large and small.

These include foreign ventures in Israel. "The yardstick is whether the company manufactures in Israel," Erlich explains. "And the emphasis is on exports. Until now, each dollar we've invested in R&D has returned between eight and 10 times as much in foreign sales."

Erlich also earmarks cash for salaries out of his budget. "On a case by case basis, we are ready to examine payments for the salaries of U.S. engineers and other staff working on R&D projects in Israel," he says.

Cooperation between the two countries to support projects with strong commercial potential has been steadily consolidated since the creation in 1978 of the Israel-U.S. Binational Industrial Research and Development Foundation (BIRD-F). The group, which is financed by both governments, matches funds with each partner in the joint development of any innovative technical product or process.

Erlich of the Ministry of Industry and Trade would like to see more involvement by Israeli businessmen and venture capital in creating new high-tech companies. "I personally favor better tax incentives, such as lower capital gains taxes for start-ups," he says. "But other government departments do not agree."

Optrotech and Orbot

Erlich singles out Optrotech, a world leader in manufacturing equipment for the optical inspection of printed circuit boards, as a company "where our money has been well spent."

"This young company is successful not only in Israeli terms, but in American terms as well," says Uzia Galil of Elron which holds 43% of Optrotech's shares.

Optrotech is confident in its future, in spite of the slump in the electronic components industry and increased competition, particularly from Orbot, its rival and fellow Israeli company. "We're going to spread out into more vision-based products," says Optrotech's president Shlomo Barak. "But, for the moment, their nature is confidential."

Orbot, which arrived in the PCB optical inspection market after Optrotech, is giving it a run for its money. The two companies now share 90% of world sales in their sector. And, like Optrotech's Barak, Hanan Gilutz, director of marketing and sales at Orbot, says: "We, too, are diversifying into new products."

With Digital Equipment Corp., Intel Corp., Motorola Inc. and National Semiconductor Corp. designing or manufacturing chips there, the integrated circuit sector is becoming increasingly important to Israel's electronics industry. Tadiran, the country's biggest electronics group, recently completed a $20 million plant at Kiriat Malachi to assemble printed circuit boards.

Igal Carmi, marketing manager of Tadiran, says the United States is buying 25% of its boards. Fifty percent go into Tadiran products and 25% are sold to other Israeli electronics manufacturers. "Even in a depressed U.S. market we can do well with a tiny share," Carmi adds.

Scitex Corporation Ltd. is an imaginative Israeli company that has found a profitable niche in interactive turnkey graphics systems. These products automate labor-intensive imaging processes in printing, publishing, printed circuit board manufacturing, energy exploration and cartography throughout the world. The bulk of Scitex's sales — more than 80% — is derived from so-called "prepress" work, the preparative procedures for printing magazines and newspapers. In 1985 Scitex earned 55% of its revenue in the U.S., 35% in Europe and the remaining 10% in Japan and other countries.

Scitex is building up substantial business in the U.S. press industry with its transportable color scanner, Satlight, which is replacing couriers and express mail services for color photographs. Rafi Bronstein, a Scitex marketing manager, says: "Not many Americans have heard about Satlight. But millions of them have seen at least 200 photos of the last Democratic National Convention and the Olympic Games which were transmitted by our scanner system."

Recessionary winds

However, with a wide range of innovative and successful companies, Israel's electronics industry is not sheltered from the cold blast of recession blowing through the industry at large. Profits for most of its high-tech companies took a beating last year. And they are worried whether 1987 will restore their fortunes.

The Israelis are also contending with other problems. Attractive jobs and salaries in the United States and Europe are competing for their best talent. Heavy taxation is triggering a brain drain whose importance is rated from negligible to serious by the men who manage Israel's electronics industry.

Dov Frohman, inventor of the eras-

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Electronic Business

June 1

- Computers
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- Plant Sites & Facilities
- Semiconductors
- Military Electronics

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June 15

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- Computer Peripherals

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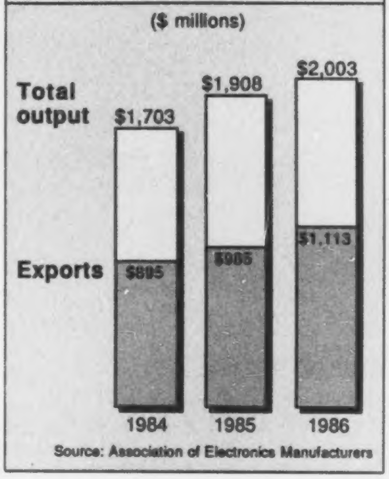
Exports account for more than half of Israel's electronics production



Source: Association of Electronics Manufacturers

able-programmable read-only memory (EPROM) and now general manager of Intel's operations in Israel says: "I doubt there's really a major exodus." He adds: "On the contrary, the atmosphere of working in Israel is so challenging that it attracts people from the U.S. and Europe and encourages Israelis to stay."

Frohman says he prefers to hire Israelis who are committed to their own country rather than those who have gone abroad to study and gain experience. "Those people tend to become prima donnas. Nine out of 10 in this category want to be plant managers. But they usually don't have the qualities needed to run an Israeli company."

However, at Elscint, a medical imaging company that ranks among the world's leaders, Natan Ron, the corporate secretary, disagrees. Ron, who, like Frohman, came to Israel from the United States — he formerly managed a law office in Washington, D.C. — says: "Israel's electronics industry still needs to attract able young people from the U.S. Israeli universities cannot cope with the demand for talent."

He is also convinced that the Israelis have a lot to learn from the United States. "In Israel, everybody wants to be king and take a chance. But what we need are men and women who are fed on coolness, discipline and reasoned judgment. The U.S. can help us by sending more of these people to teach our own bright youngsters about strategic planning. In Israel we are strong on hutzpah and innovation. But we are not well organized."

Ron argues that young Israelis who go to the United States for schooling and professional experience become major assets to their country's electronics industry when they return home. "Most of our production heads here at Elscint are ex-paratroopers," he remarks. "Taking leave of business contacts with a 'Have a nice day' is alien to their culture. So exposure to the U.S. environment helps to rub off some of the edges."

He stresses that, during their three years of compulsory military service, young Israelis become immersed in electronics. This experience makes them keen and able to take jobs in the high technology sector when they come out into the working world, Ron adds.

Elron's Galil says: "It's good for Israelis to go abroad to study and work. But the problem is to ensure they come back. I'm not sure we have got the right balance in and out. We have to motivate these people to ensure they come back. And not 15 years later, but after five."

But the heavy hand of government bureaucracy and high taxation are certainly discouraging both Israeli and U.S. engineers and managers from making careers in the country's electronics industry. Israel's income tax leaves only $10,000 out of an engineer's $30,000 annual salary.

"We have a very high rate of new regulations covering taxation and foreign exchange which can act as a deterrent," says Frohman. He quotes his own embarrassment at having to let a Japanese colleague foot a hotel bill in Tokyo because the Israeli government would not let him take enough foreign currency for his trip.

Frohman also emphasizes the need for Israeli managers to learn manufacturing disciplines. "They need to become competitive while producing in automated plants. This is something which they are not all that good at," says the Intel veteran. He adds: "Not enough focus has been put on manufacturing discipline in Israel until now."

Elron's Galil is concerned about what he and other Israeli businessmen regard as excessive state intervention in the country's industry. "If the state sells the enterprises that it controls, relaxes taxation and foreign exchange restrictions, there will be a boom in Israel," he says. "But the present situation is handicapping motivation — both for investors and the people who work in our high-tech companies."

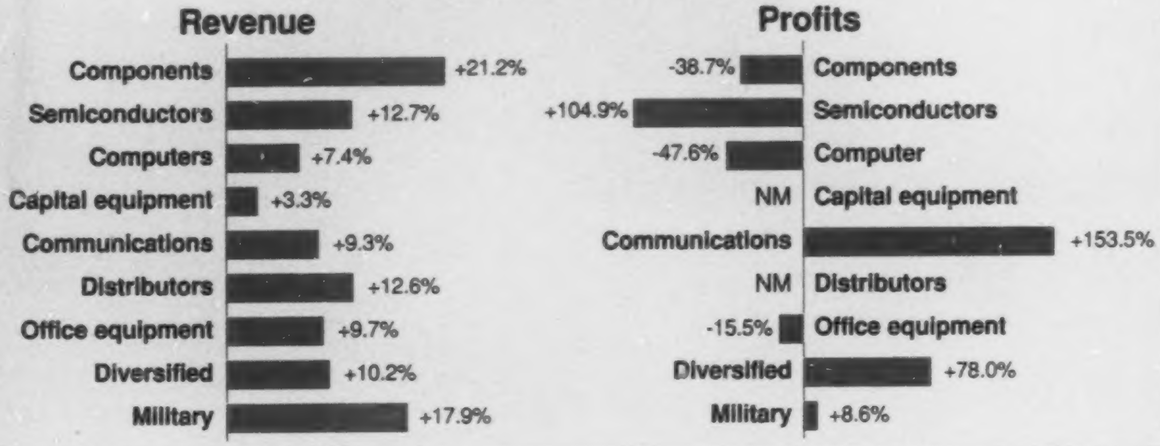
JACK GEE

QUARTERLY SCORECARD

Financial results of leading U.S. electronics companies

Industry segment averages

Percentage change from 4th quarter of 1985 to 4th quarter of 1986



Components (Other than semiconductors)	Revenue 4th quarter 1986 ($ millions)	Change from 1985	Profits 4th quarter 1986 ($ millions)	Change from 1985	Revenue year-to-date 1986 ($ millions)	Change from 1985	Profits year-to-date 1986 ($ millions)	Change from 1985	Quarter ended
AMP	$506.0	+21.9%	$46.0	+110.1%	$1,933.0	+18.1%	$164.0	+51.9%	Dec. 31
AVX	50.5	+18.0%	1.0	-81.4%	195.4	+9.3%	3.1	-74.8%	Dec. 31
Augat	64.5	+0.1%	-15.7	NM	260.4	+2.1%	-8.7	NM	Dec. 31
CTS	65.5	+20.9%	-21.5	NM	245.5	-6.1%	-23.8	NM	Dec. 28
Molex	91.8	+39.9%	9.5	+31.9%	349.4	+36.8%	38.9	+37.7%	Dec. 31
Segment composite	**$778.3**	**+21.2%**	**$19.3**	**-38.7%**	**$2,983.7**	**+15.3%**	**$173.4**	**+20.1%**	
Semiconductors									
Advanced Micro Devices	$150.2	+4.3%	-$17.7	NM	$615.2	-1.4%	-$103.9	NM	Dec. 28
Intel	355.6	+11.9%	-16.4	NM	1,265.0	-7.3%	-183.3	NM	Dec. 31
International Rectifier	38.6	+10.7%	-1.9	NM	151.7	+7.5%	-6.6	NM	Dec. 31
LSI Logic	54.5	+31.5%	1.7	-54.9%	194.3	+38.8%	3.9	-61.9%	Dec. 31
Texas Instruments	1340.0	+10.7%	26.6	NM	4,970.0	+1.0%	39.9	NM	Dec. 31
Western Digital	109.8	+56.9%	10.5	+125.6%	346.1	+48.2%	32.8	NM	Dec. 27
Segment composite	**$2,048.8**	**+12.7%**	**$2.8**	**-104.9%**	**$7,542.3**	**+1.6%**	**-$217.2**	**NM**	
Computers and peripherals									
Amdahl	$336.8	+30.9%	$27.1	+188.0%	$966.3	+12.1%	$39.3	+61.1%	Dec. 26
Apollo	120.9	+71.0%	5.3	+623.6%	391.7	+32.5%	9.3	NM	Jan. 3
Apple	662.3	+24.0%	58.5	+2.7%	2,030.3	+15.8%	155.5	+115.8%	Dec. 26
COMPAQ	186.9	+19.6%	16.2	+62.3%	625.2	+24.1%	42.9	+61.3%	Dec. 31
Conrac	43.6	+16.3%	2.1	-5.2%	153.9	+2.4%	7.8	+8.4%	Dec. 31
Control Data	903.6	-7.9%	-17.3	NM	3,346.7	-9.0%	-102.3	NM	Dec. 31
Convergent	77.4	-34.9%	-4.5	NM	305.8	-33.4%	-32.8	NM	Dec. 31
Cray Research	138.2	+63.1%	23.3	+93.8%	596.7	+57.0%	124.8	+65.1%	Dec. 31
Data General	313.3	+6.7%	3.3	+200.0%	1,287.5	+7.4%	7.9	+237.4%	Dec. 27
DEC	2,271.8	+22.0%	270.0	+98.3%	8,414.3	+19.7%	861.6	+115.1%	Dec. 27
Honeywell	1,617.1	+7.9%	-97.5	NM	5,378.2	+7.7%	12.9	-94.1%	Dec. 31
IBM	16,945.0	-1.2%	1,390.0	-48.2%	51,250.0	+2.4%	4,789.0	-26.9%	Dec. 31
Mentor Graphics	49.3	+34.6%	3.9	+137.5%	173.5	+26.9%	11.0	+37.7%	Dec. 31
Micropolis	51.8	+43.1%	5.1	+128.5%	213.1	+124.6%	18.3	+557.2%	Dec. 26
Miniscribe	52.9	+48.5%	6.4	+157.7%	184.9	+62.2%	22.7	+35.4%	Dec. 31
Prime	230.9	+10.0%	14.2	-18.9%	860.2	+11.8%	46.9	-18.8%	Dec. 31
Sun Microsystems	115.3	+173.3%	8.5	+405.6%	341.1	+131.9%	24.5	+204.9%	Dec. 26
Tandem	238.0	+40.0%	27.1	+132.6%	835.8	+31.7%	79.2	+147.6%	Dec. 31
Telex	212.5	+20.4%	18.3	+3.0%	817.0	+19.6%	72.7	+8.4%	Dec. 31
Unisys	2,535.8	+71.3%	-188.5	NM	7,432.4	+47.5%	-43.4	NM	Dec. 31
Segment composite	**$27,103.3**	**+7.4%**	**$1,571.5**	**-47.6%**	**$85,604.7**	**+8.4%**	**$6,147.9**	**-18.5%**	

NM = not meaningful

Continued

QUARTERLY SCORECARD

Financial results of leading U.S. electronics companies

Capital equipment	Revenue 4th quarter 1986 ($ millions)	Change from 1985	Profits 4th quarter 1986 ($ millions)	Change from 1985	Revenue year-to-date 1986 ($ millions)	Change from 1985	Profits year-to-date 1986 ($ millions)	Change from 1985	Quarter ended
Computervision	$136.5	+16.5%	$3.5	NM	$494.7	+12.2%	-$5.8	NM	Dec. 31
Fluke	51.2	-1.0%	2.6	-18.4%	208.5	-2.9%	11.6	-20.3%	Dec. 31
GenRad	61.5	+24.0%	-1.5	NM	204.3	-6.4%	-29.9	NM	Dec. 31
Spectra-Physics	48.7	-2.6%	0.1	+25.9%	208.8	+5.0%	0.9	NM	Dec. 31
Tektronix	320.2	-0.7%	17.4	+36.2%	1,352.4	-4.7%	55.1	-21.4%	Nov. 15
Teradyne	73.6	-0.4%	0.1	-77.5%	306.1	-9.0%	0.2	-98.9%	Dec. 31
Varian	214.9	+1.1%	2.4	+42.3%	908.3	-4.3%	-14.2	NM	Jan. 2
Segment composite	**$906.5**	**+3.3%**	**$24.6**	**NM**	**$3,683.1**	**-2.5%**	**$17.9**	**NM**	
Communications									
Andrew	$48.7	+0.6%	$2.3	+0.7%	$198.0	-4.7%	$9.5	-21.9%	Dec. 31
Avantek	70.8	+16.9%	5.5	-25.4%	208.2	+23.7%	16.1	-12.1%	Dec. 31
Aydin	34.4	-2.4%	1.6	+67.9%	136.8	+2.8%	7.0	+83.0%	Dec. 31
DSC Communications	74.5	-3.3%	2.4	NM	304.0	+5.7%	11.0	NM	Dec. 31
Dynatech	76.0	+13.0%	6.4	+21.0%	281.3	+9.6%	23.5	+2.5%	Dec. 31
General DataComm	52.3	+27.3%	1.4	-5.0%	189.5	+5.2%	3.9	-55.9%	Dec. 31
Micom Systems	50.5	+2.8%	3.5	-16.6%	191.6	-1.4%	9.5	-34.9%	Dec. 31
Northern Telecom	1,310.0	+10.1%	132.2	+46.2%	4,380.0	+2.8%	313.2	+4.7%	Dec. 31
Paradyne	63.8	+5.9%	-26.3	NM	261.1	+3.4%	-37.6	NM	Dec. 31
Segment composite	**$1,780.9**	**+9.3%**	**$129.0**	**+153.5%**	**$6,150.4**	**+3.5%**	**$356.1**	**+20.2%**	
Distributors									
Arrow Electronics	$132.5	+10.7%	-$6.8	NM	$529.6	-0.8%	-$28.7	NM	Dec. 31
Avnet	375.9	+10.7%	4.6	-41.0%	1,476.5	+6.6%	18.6	-43.4%	Dec. 31
Marshall Industries	66.7	+18.4%	0.8	+438.6%	269.2	+16.2%	4.5	+205.7%	Nov. 30
Pioneer-Standard	54.3	+4.5%	0.3	NM	214.2	+3.4%	-0.4	NM	Dec. 31
Wyle	81.1	+27.9%	1.1	+90.3%	307.0	+17.7%	4.3	+184.5%	Jan. 31
Segment composite	**$710.5**	**+12.6%**	**$0.0**	**NM**	**$2,796.5**	**+6.8%**	**-$1.7**	**NM**	
Office equipment									
Diebold	$109.9	-1.2%	$10.0	-4.0%	$413.7	+0.7%	$34.9	+14.8%	Dec. 31
NBI	69.8	-2.0%	-4.0	NM	283.1	+8.6%	-10.4	NM	Dec. 31
NCR	1,575.1	+12.1%	134.1	+0.6%	4,881.6	+13.1%	336.5	+6.8%	Dec. 31
Pitney Bowes	563.4	+10.2%	53.9	+10.6%	1,986.7	+9.4%	166.1	+17.2%	Dec. 31
Savin	82.5	-10.8%	-0.9	NM	362.7	-8.7%	-11.1	NM	Dec. 31
Wang	668.9	-1.6%	-78.6	NM	2,668.9	+9.9%	-86.4	NM	Dec. 31
Xerox	3,700.0	+12.1%	138.0	+21.1%	12,900.0	+10.3%	488.0	+28.1%	Dec. 31
Segment composite	**$6,769.6**	**+9.7%**	**$252.5**	**-15.5%**	**$23,496.6**	**+10.2%**	**$917.6**	**+18.1%**	
Diversified									
General Instrument	$262.0	+31.1%	$2.0	NM	$871.7	+8.5%	$15.4	NM	Nov. 30
Gould	227.4	-2.5%	5.5	-66.9%	908.8	-1.6%	34.6	NM	Dec. 31
Harris	534.3	-5.6%	20.1	+38.7%	2,106.4	-9.0%	68.6	+13.0%	Dec. 26
Motorola	1,619.0	+11.8%	63.0	+43.2%	5,888.0	+8.2%	194.0	+169.4%	Dec. 31
N.A. Philips	1,356.0	+2.3%	60.3	+125.8%	4,531.6	+3.1%	81.2	-0.4%	Dec. 31
Tandy	1,196.0	+19.5%	103.8	+19.3%	3,322.8	+16.2%	225.9	+12.0%	Dec. 31
Zenith	597.1	+23.4%	0.4	-88.9%	1,892.1	+16.5%	-10.0	NM	Dec. 31
Segment composite	**$5,791.9**	**+10.2%**	**$255.1**	**+78.0%**	**$19,521.5**	**+6.3%**	**$609.7**	**+184.0%**	
Military									
E-Systems	$301.0	+24.8%	$14.9	-2.1%	$1,135.1	+22.5%	$61.6	+3.5%	Dec. 31
Electrospace Systems	46.4	+25.6%	2.6	-26.1%	179.9	+35.0%	10.0	-20.3%	Jan. 2
Logicon	49.1	-2.6%	2.2	-9.5%	204.5	+7.7%	9.3	-3.7%	Dec. 31
Loral	165.2	+1.0%	13.3	+3.6%	683.6	+14.1%	56.6	+16.3%	Dec. 31
Raytheon	2,041.2	+19.2%	99.6	+0.9%	7,308.0	+14.0%	393.2	+4.6%	Dec. 31
Tracor	171.3	+19.3%	6.7	NM	632.1	+15.7%	18.8	+40.9%	Dec. 31
Watkins-Johnson	64.5	+7.0%	3.6	-41.6%	255.4	+9.8%	17.2	-6.5%	Dec. 31
Segment composite	**$2,838.8**	**+17.9%**	**$142.9**	**+8.6%**	**$10,398.6**	**+15.1%**	**$566.8**	**+5.3%**	

NM = not meaningful

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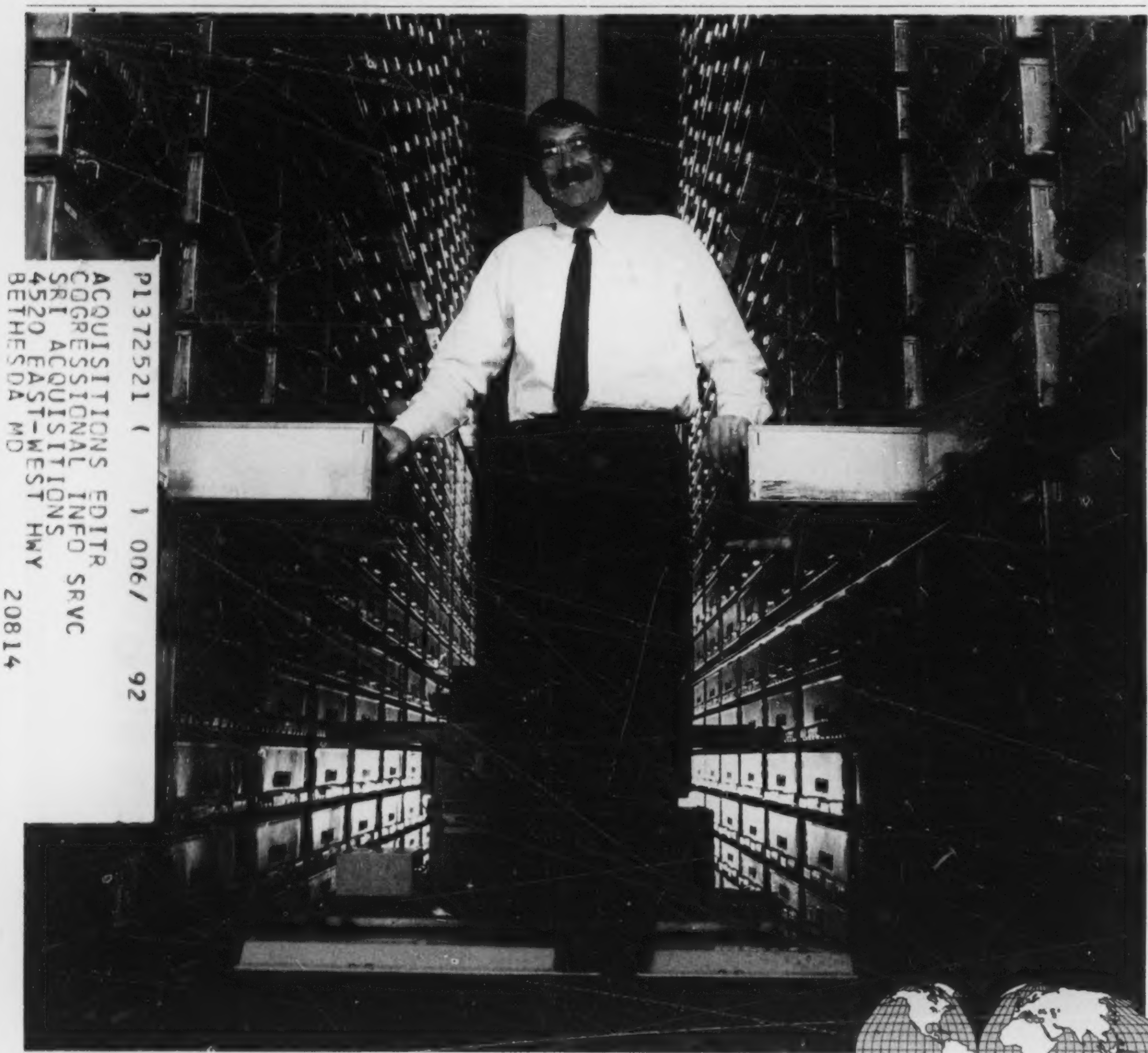
SIX DOLLARS

Electronic Business

IC equipment makers: Wiser, leaner and more businesslike

Fastest growing companies: The ones to watch in 1987



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Arrow's Stephen Kaufman: Managing the ups and downs of distribution

International directory of sites and facilities

Electronic Business

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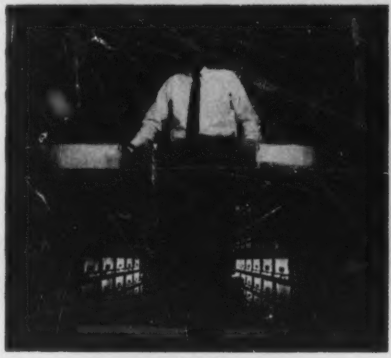

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BPA ABP

All signs point to a stronger second half

Distributors have hung on during tough times. Now look for a modest recovery in key markets

Everyone in the distribution business is forecasting a recovery this year but no one is expecting anything of monumental proportions. Still the signs of better days are already here. The first quarter started slowly but ended strongly. Anthony Hamilton, chairman of top-ranked Avnet Inc., expects a slow revival this year and a great 1988. Most industry watchers agree about 1987, but there is less certainty about 1988.

"There is a lot of optimism right now," says Craig Conrad, vice president of semiconductor marketing for Schweber Electronics Corp., referring to the semiconductor outlook. Schweber, he says, is planning for between 6% to 8% growth for 1987 in semiconductors, but the suppliers are looking at closer to 15% for the year. This is significant because, according to the Semiconductor Industry Association, the distribution share of suppliers' IC shipments hit record highs in 1986.

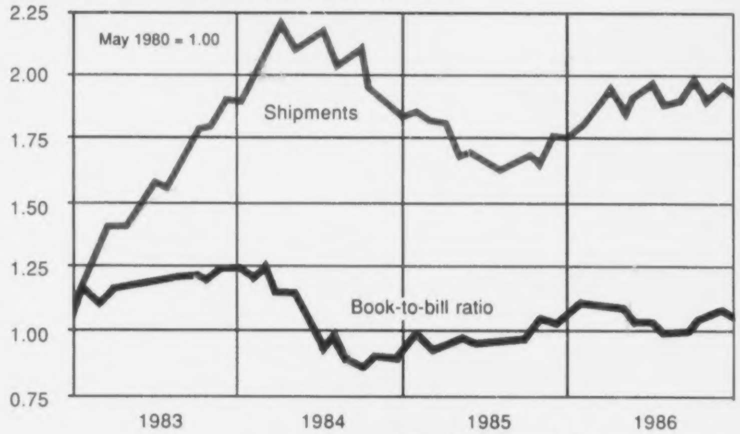
However, plenty of chips that were shipped stayed on distributors' shelves last year, and distribution margins were razor thin. Now, inventories are way down, margins are improving and leadtimes are stretching out. The National Electronic Distributors Association's book-to-bill ratio (for all products, not just integrated circuits) hit 1.11 in February, the highest value since May 1984. Shipments fell slightly last December but have picked up strongly in the first quarter of this year.

"The unusual thing about this uptick in semiconductor business is that it is supplier led and not distribution led," says Conrad. This is further evidence that this recovery could be substantive. "The suppliers have basically seen four to five months of strong bookings, and distribution hasn't really seen anything, except in the last couple of months," he says. The availability and capacity are there at the supplier level, and the inventory levels are significantly lower as well.

Combining the domestic recovery with the drop in the dollar could mean Japanese commodity chips will have a tougher time in the U.S. market. But agreements between Intel Corp. and Samsung, and also Motorola Inc. and Toshiba, imply a recognition that nationalist distinctions are not always in the best interest. These new international relations could mean another round of musical franchises: hardly a stabilizing influence at this time.

Stephen Kaufman, president and chief executive at Arrow Electronics Inc., believes that where the product is made and whose name is on it is really not important. What is important is that the Japanese and the Koreans have established a strong cost-competitive and product-quality position in some semiconductor lines, and Kaufman and other distributors would like to carry those products.

BRUCE C.P. RAYNER

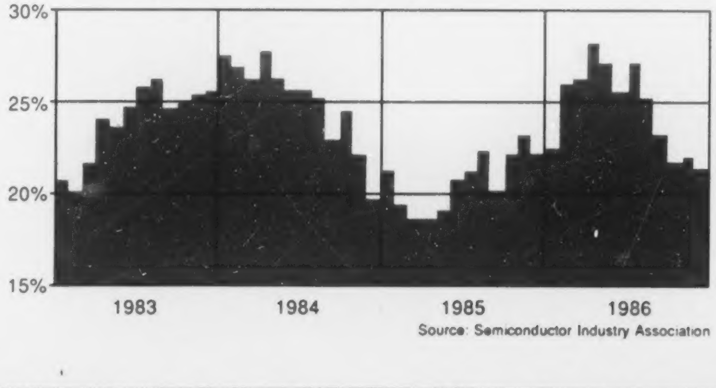


Distribution business index

Source: National Electronic Distributors Association

Distributors' share of IC shipments

(Percentage of U.S./Canadian shipments)



Source: Semiconductor Industry Association

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, has been climbing steadily since the summer of 1986. The fourth quarter was up 0.7% from the prior quarter bringing yearly production up 1%. This year, modest gains are expected to continue through midyear with sharper increases in industrial production expected in the third and fourth quarters.

The Cahners Early Warning Indicator (CEWI) is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index. It forecasts probable business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 104.1 level forecast using the CEWI for the end of this year indicates that the average for all of 1987 should be 4.1% above 1986.

Readers can obtain a brochure explaining the CEWI method from Cheryl Patstone, economist, Cahners Economics Department, 3021 Tisch Way, Suite 100, San Jose, Calif. 95128.

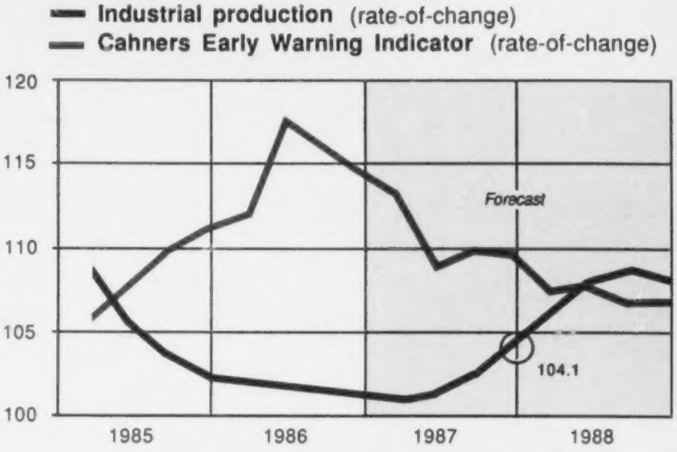
Electronic components

Component production, which was relatively flat in the first three quarters of 1986, jumped 2% during the fourth quarter and reached its highest level since mid-1985. But this advance came too late to prevent the market from posting an annual loss of 5.4%. The outlook for 1987 is much brighter, since major component users (such as the computer and telecommunications industries) are finally seeing an improvement in business. By the end of the year, component production should be running more than 15% ahead of the level at the start of 1987, and this brisk uptrend will lead to an overall annual growth of 10.3%. A gain of 18.2% is expected in 1988.

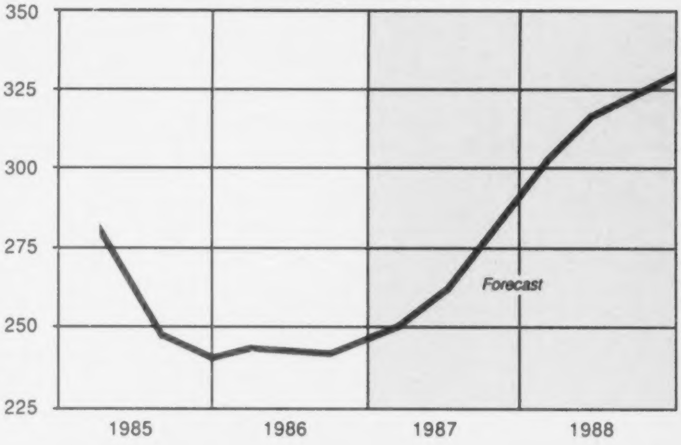
Equipment, instruments and parts

Production of scientific and engineering instruments grew 2.3% in the fourth quarter of 1986, after a lackluster performance earlier in the year. This spurt in activity lifted the yearly growth rate to 4.2%, nearly double the 2.2% pace for 1985. Much of the expansion in 1986 was focused in the areas of defense equipment and medical electronics. In 1987, the source of growth is expected to shift toward industrial-related segments such as process controls and electronic test and measurement equipment. Look for production to show an overall gain of 4.9% (in real terms) this year, with much of the improvement coming in the second half. Growth will accelerate 10.2% next year.

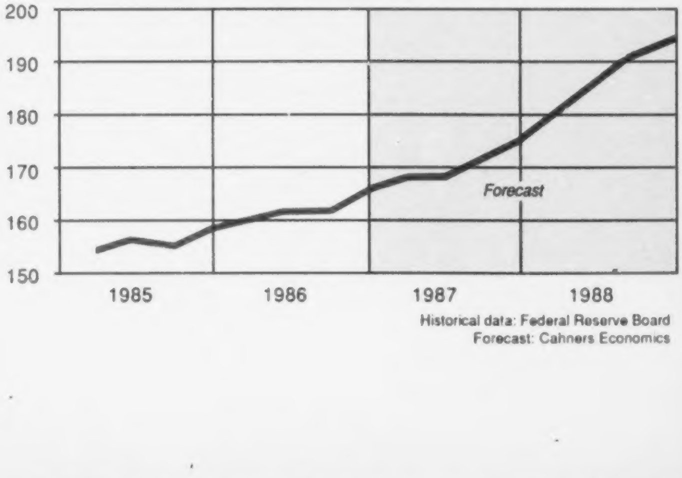
Economic indicators



Industrial production: Electronic components
(1977 = 100, quarterly averages)



Industrial production: Equipment, instruments and parts
(1977 = 100, quarterly averages)



Historical data: Federal Reserve Board
Forecast: Cahners Economics

New orders

Component manufacturers received an estimated $10.02 billion in new orders in 1986's fourth quarter, up from an $8.72 billion for the previous quarter. This rise resulted in part from distributors and original equipment manufacturers restocking their inventories in anticipation of improved business conditions this year. The U.S. industrial sector is now several months into an expansion and is expected to sustain the rise throughout 1987. This will help to push component demand higher as the year progresses. Orders, which rose 7.9% to $38.8 billion in 1986, are expected to increase at a slightly faster 12.9% in 1987.

Unfilled orders

Manufacturers' order backlogs averaged just $14.8 billion in last year's fourth quarter, the lowest level since mid-1983 and down from a $15.5 billion figure in the third quarter. On a yearly basis, backlogs shrunk 8.5%, a disappointment to manufacturers since it followed on the heels of a steep 20.6% loss in 1985. Now that the order slump appears to be over and industrial markets are getting back on solid footing, backlogs should once again begin to build, probably during the first half of this year. Backlogs are expected to reach an annual average of $17.1 billion for 1987, up 9.9%.

Shipments

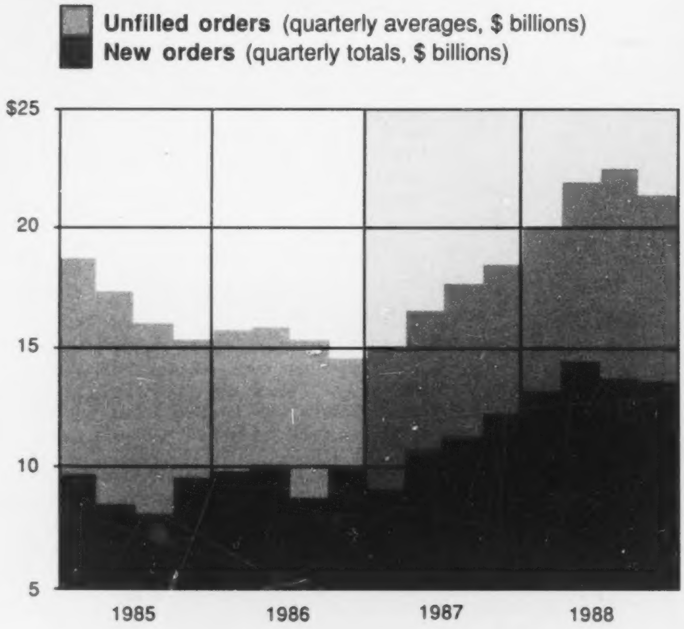
Fourth quarter shipments of electronic components were valued at $9.89 billion, up slightly from $9.74 billion in the previous quarter and 6.8% ahead of the year-ago pace. Annually, shipments reached $39.6 billion, a gain of 1.8%. The year-end turnaround in orders and expectations of improvement in the U.S. industrial sector over the course of 1987 makes the outlook for the next 12 months somewhat brighter. After a slow start in the first quarter, shipments are expected to rise more rapidly in mid-to-late 1987. For the year, shipments are forecast to increase 7% to $42.4 billion.

Inventory-to-shipment ratio

The inventory to shipment ratio for components continued to decline in last year's fourth quarter, reaching an average of 1.77. This was the lowest level since year-end 1984 and was well below the peak for this cycle (2.02) which occurred in June 1985. When the ratio is high it usually means that manufacturers need to liquidate inventory; when low, it may indicate a need for replenishment. Readings for late 1986 (and preliminary reports for early 1987) suggest that inventories are at a lean but reasonable level for this stage of a business expansion. The I/S ratio is expected to edge down slowly over the next 18 to 24 months, as it typically does when business conditions are improving.

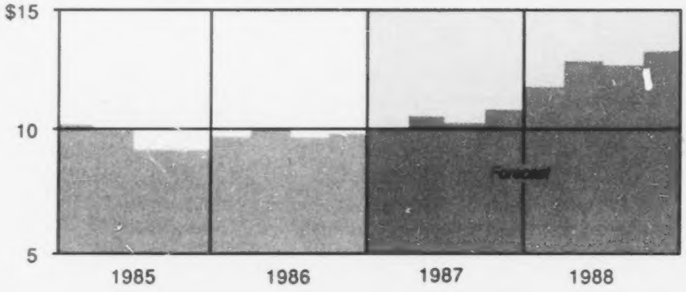
Electronic components

(SIC 367)



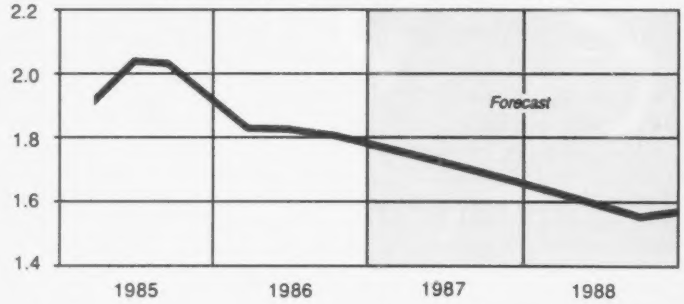
Electronic components: Shipments

(quarterly totals, $ billions)



Electronic components: Inventory-to-shipment ratio

(seasonally adjusted, quarterly averages)



Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

most," says General Lew Allen Jr., head of the NAS study group and former director of the National Security Agency. "But the impact on business is not unimportant," he adds.

Industry officials agree with the NAS that it is a mistake to equate the loosening of export controls with a disregard for national security. "Our members are as concerned as anyone else," says CBEMA's Maxwell. "We all have a common goal. We are all Americans." Concurs Dwight of Spectra-Physics: "What we're trying to do is build higher fences over a limited number of products and still deny the Soviets anything truly detrimental to our national security."

The High Technology Trade Promotion Act, introduced by Frenzel and AuCoin, would, among other things, eliminate the Defense Department's "de facto veto" — also a recommendation of the NAS panel. The legislation would reaffirm the role of the Commerce Department as the ultimate authority in processing export licenses. It would also eliminate requirements for: export licenses on high-tech items shipped to U.S. allies; reexport licenses for products exported to and imported from allied countries; and export and reexport licenses on low-technology products shipped to and from other Western countries.

Commerce, meanwhile, has implemented internal reforms of its own including: proposed implementation of new general licenses that reduce the licensing burden for U.S. exporters and CoCom partners; plans to revise its parts and components regulations to address the de-Americanization problem; elimination of licensing requirements for low-level exports to non-CoCom countries in the West, and reduction or elimination of the need for U.S. authorization for reexports into CoCom countries.

Commerce also has proposed legislation that when a product or technology similar to a U.S. product is available to another Western country without restrictions, that U.S. product qualifies for a license to that country. That license would be granted in 20 days unless an unacceptable risk of diversion is shown. Moreover, Commerce says that this year it will meet President Reagan's goal of reducing license times by one-third — from 20 days to 14 days. Licenses for CoCom partners are processed in only about seven days.

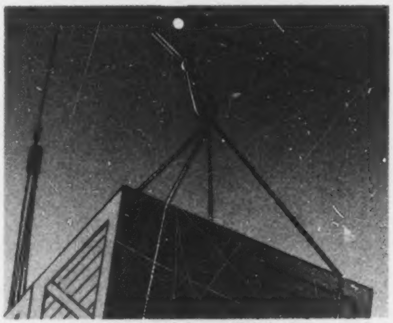
In Commerce's legislative package, the department will provide authority to allow for exports to the People's Republic of China under the distribution license. Companies with distribution licenses are constantly monitored by Commerce and Defense and do not have to reapply for an export license every time they ship a product to an approved foreign customer.

That's good news for semiconductor equipment makers that have a distribution license. China is "potentially a very important market," says Ciesinski of SEMI. If the proposed legislation and other changes in the export control system do not become a reality, industry leaders worry that U.S. technology firms will continue to lose out to foreign competitors, both in emerging markets like China and even in the West. "The Japanese can do it. The Europeans can do it. And it won't be long before the Koreans can do it," worries Perrone. "We really have to limit restrictions to critical military technology. It's gotten to the point where there's a reason to deny anything."

BETH KARLIN

Currency fluctuations pave the way for U.S. exports

Despite export control problems, there's been a resurgence in electronics exports, especially to Europe



A year ago, Monolithic Memories Inc. was selling one of its programmable array logic (PAL) products for Fr18 to its French customers. Today, partly because of international currency fluctuations, that same device costs Fr10. As a result, the Santa Clara, Calif., semiconductor company has been able to gain market share against Japanese rivals offering PAL alternatives like gate arrays or transistor-to-transistor logic devices.

Like many other U.S. companies that have kept their manufacturing onshore, MMI is realizing the benefits of the overseas currency swings of the past two years. Although U.S. industry as a whole has seen only disappointing export gains, many U.S. component and computer firms are performing well in international markets, particularly Europe. Hewlett-Packard Co., for example, reported a 23% rise in international revenue and a 24% increase in international orders during the quarter ending January 31. Domestic revenue, by contrast, fell by 2% while domestic orders inched ahead by just 3%.

At Tektronix Inc., international revenue as a percentage of total revenue climbed from 36% to 41% last year. IBM's international business, up 20.2% in 1986, kept the armadas of Armonk afloat as domestic sales shriveled. Currency gains actually contributed $645 million to IBM's 1986 profits, according to chairman John F. Akers.

Overall, reports John McPhee, director of the U.S. Commerce Department's Office of Computers and Business Equipment, U.S. exports of computers and business equipment were up by 5% in 1986. But that modest gain masks the real story: a very forceful pickup in the second half of the year. After actually declining in the first half of the year, exports rose by 20.4% from $6.47 billion to $7.79 billion.

Although much has been made of the fact that the dollar has not weakened against the currencies of Korea and Taiwan, enabling these low-cost Asian producers to build their electronics bases, the simple truth is that these countries do not yet have the industrial capacity or broad product range of U.S. industrial rivals in Japan, France and Germany. It is also worth noting that three of Taiwan's top four exporters (Digital Equipment Corp., General Electric Co.'s RCA Corp. subsidiary and Texas Instruments Inc.) are U.S.-based firms [ELECTRONIC BUSINESS Dec. 10, 1986

Exports of U.S. computer equipment are on the rise

U.S. domestic exports ($ thousands)

Country	1985 July - December	1985 Total	1986 July - December	1986 Total
Total	$6,474,933	$13,964,031	$7,789,092	$14,669,276
Canada	$1,011,608	$2,167,205	$940,287	$1,930,099
Latin America				
Brazil	$123,228	$248,232	$146,482	$274,441
Mexico	202,567	398,110	177,098	369,960
Venezuela	57,522	98,464	63,413	119,223
Total	$578,137	$1,099,094	$592,017	$1,124,057
Western Europe				
Austria	$22,296	$43,250	$26,297	$44,535
Belgium and Luxembourg	127,922	265,077	189,944	336,784
Denmark	29,105	69,780	44,101	73,764
France	376,506	848,247	475,455	892,960
Greece	3,930	12,038	6,783	13,110
Ireland	237,402	525,870	320,878	583,284
Italy	192,435	410,450	281,227	484,495
Netherlands	304,774	673,718	411,231	778,376
Sweden	92,775	186,290	98,803	191,545
Switzerland	91,726	235,625	123,904	224,322
Britain	785,169	1,747,814	945,415	1,813,937
West Germany	589,826	1,294,646	800,164	1,505,768
Total	$3,013,437	$6,654,711	$3,927,864	$7,340,478
East Asia				
Hong Kong	$131,467	$347,281	$143,673	$278,675
Japan	569,982	1,265,297	707,685	1,334,745
Philippines	18,542	32,513	18,143	37,334
Singapore	199,708	415,442	264,473	471,421
South Korea	101,382	200,318	153,616	242,405
Taiwan	106,788	223,715	147,848	264,468
Total	$1,267,694	$2,765,269	$1,638,502	$2,969,598
All other countries				
India	$27,140	$54,415	$48,325	$83,595
Israel	88,924	173,237	80,383	155,033
South Africa	50,683	118,180	63,360	123,404
Saudi Arabia	63,109	111,885	42,338	79,761
Total	$604,057	$1,277,752	$690,422	$1,305,053

Source: U.S. Department of Commerce

p28]. Meanwhile, the declining value of the dollar against the yen, franc and deutsche mark has made U.S. product more competitive in Europe and indeed anywhere that the competition is Japanese, French or German.

Suddenly cast in the unfamiliar roles of low-cost producer and potential price leader, many U.S. electronics firms have had an interesting choice. Do they simply pocket their currency translation gains or do they pass them on to customers in the form of lower prices? This, in essence, is the inverse of the choice faced by Japanese exporters, who have had to decide between raising prices or lowering profit margins to retain market share. The Japanese, consistent with tradition, have sacrificed quarterly earnings to maintain market strength. But not all American firms have chosen to emphasize market share over profit.

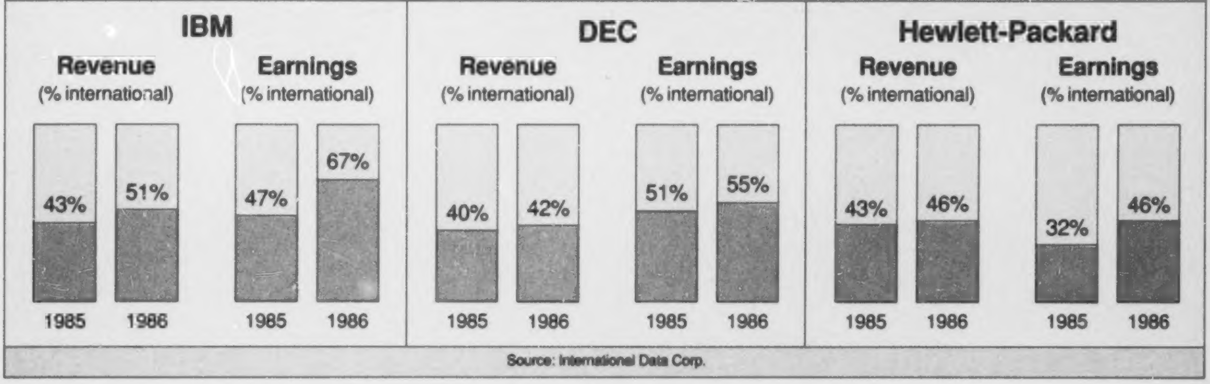
Philosophic choices

Socket and connector maker Augat Inc. of Mansfield, Mass., for example, is not lowering prices. "Our philosophy is not to pass through the dollar impact in any case unless it's absolutely necessary for competitive and strategic circumstances," explains Stephen Gallant, manager of finance and administration for Augat's international division. Gallant says that if Augat cut its prices, others would simply follow suit. Besides, he adds, orders are "absolutely going great guns."

Many American companies have split the currency gains with their customers. John Fluke Manufacturing Co., for example, has lowered prices on some of its exports to Germany by roughly 25% during the time the German deutsche mark has appreciated by 50%. Even with such reductions, the Everett, Wash., instrument maker has come out a winner, according to vice president of international operations Ron Wambolt. Profits in Europe "were double what was budgeted" for the fourth quarter of 1986, according to Wambolt.

Monolithic Memories, in choosing to pass currency gains on to its customers, has opted for market share over profits. "We have tended to pass on the currency savings in an effort to hold on to and increase our market penetration," explains Bryan Rooney, MMI's director of international sales. (At press time ELECTRONIC BUSINESS learned that Rooney is now with Silicon Systems Inc.) In the case of the PAL product whose price has fallen from Fr18 to Fr10, about Fr4.5 of the drop is attributed to MMI's lowered costs as the product reached volume production. The rest — about Fr3.5

Computer giants profit from international sales surge



Source: International Data Corp.

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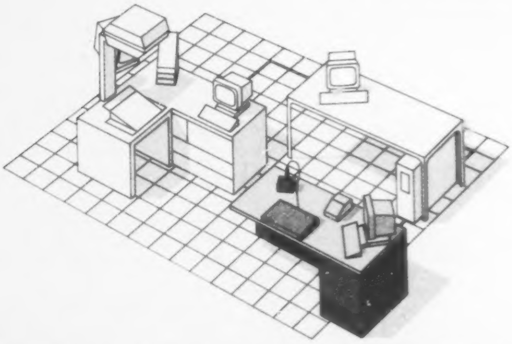

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— is the result of MMI's savings from producing in America and selling in France. "The customer is saving Fr3.5 purely as a result of currency rates," Rooney notes. Although the Japanese do not sell PAL products in Europe they do sell PAL alternatives like gate arrays. "Our objective is to make the PAL product family more competitive to other solutions." Rooney says MMI does sell bipolar programmable read-only memories in direct competition with Fujitsu and contends that the California producer "has gained share against Fujitsu in Europe" with these memory products.

Winners and losers

Interestingly, MMI and other smaller companies, which never built production facilities in Europe, are the ones gaining the full benefits of dollar weakness. Meanwhile, U.S. firms that built European plants are realizing diluted benefits. Augat, for example, has production in Switzerland as well as in the United States. "If you make product in the U.S. and sell it in Europe, Europeans can buy it up to 40% cheaper than they did one and a half years ago. However, if you're manufacturing in Switzerland, for example, as we do, the product costs approximately the same as it did a year and a half ago," explains Augat's Gallant.

The biggest losers from the global currency readjustments of the past 18 months have been the Japanese [ELECTRONIC BUSINESS Nov. 1, 1986 p76]. Of course, it is often forgotten that the remarkable Japanese ascendancy of the last half decade coincided with the strengthening of the dollar in the early years of this decade. Now they are seeing the other side of the coin. "I wouldn't call them a low-cost source anymore," says Richard Locke, manager of international procurement for Hewlett Packard Co.

HP, says Locke, now purchases monochrome monitors from Korea and liquid crystal displays from a Singapore supplier. These were only recently virtual monopoly markets for the Japanese, who are now competing more on the basis of technology than price, according to Locke. The fall of the dollar against European currencies has also put the brakes on HP's thrust toward buying European-made components for the systems it markets in Europe. Locke says U.S. suppliers are not yet winning back business from Europeans, but the pace of conversion to local content has slowed.

NORM ALSTER

Why monochrome monitors could make a comeback

Nobody's making money today in black-and-white monitors, but there may be a niche opening up in desktop publishing

Desktop publishing is hot — some might say "hyped." Doing publishing functions on a personal computer requires a little extra in the way of hardware, including a high-resolution black-and-white display. That is prompting a resurgence of activity by U.S. monochrome monitor makers, which provide the innards of those screens.

"Desktop publishing is definitely the big emerging market," says L. Richard Lemke, vice president of Dotronix Inc. The New Brighton, Minn., company makes high resolution black-and-white monitors for resale by makers of PC add-on boards. "Our initial thrust was CAD/CAM [computer-aided design and manufacturing] but the real volume is from publishing," Lemke says. He expects publishing will push his monitor sales up 30% to 50% this year and continue at that rate for another year or so.

Desktop publishing is also an important new market for Moniterm Corp. of Minnetonka, Minn. Until recently, Moniterm, which also makes monochrome monitors, sold only into the original equipment manufacturing (OEM) chain. Workstation customers include Computervision Corp. and Sun Microsystems Inc., according to James Walters, a Moniterm regional sales manager. Its first product under its own label is aimed specifically at design automation and publishing. Walters thinks there is the potential to upgrade as much as 5% to 10% of the IBM PC AT population to big screens.

One systems integrator that is riding the crest of the wave of demand for publishing systems is E-Machines Inc., a Tualatin, Ore., start-up that sells an add-on monitor and graphics board for Apple Computer Inc. hardware. Right now, E-Machines buys a big screen from Matsushita Electric Industrial Co.'s Panasonic subsidiary that it plugs into Apple's Macintosh personal computer. To date, E-Machines president Steven Vollum says he has sold over 1,000 displays for publishing. The primary reason for going with Panasonic, he says, is quality control. "As [Panasonic's monitors] roll off the boat, one after another, they're all the same," he says. "Our concern is: can a domestic supplier do that?"

Some system integrators warn, however, that the computer-aided publishing business may not develop as quickly as some industry experts think. Michael D'Agostino, vice president for marketing at Princeton Graphic Systems, a Princeton, N.J., subsidiary of Intelligent Systems Corp., notes, for example, that desktop publishing is, "almost, for the time being, a spur to the PC business." That may make for "an explosive area of growth" for the monochrome business, says D'Agostino, who buys his monitors from Liberty Electronics Co. in Taiwan. Right now, however, the software for publishing is still lacking. "The monitors are just sitting there," D'Agostino says, "The software is one and a half years behind the hardware."

Monochrome makers, particularly those in the United States, hope that the desktop publishing market turns out to be more than just a fad. The monochrome business "is not so profitable [because] the competition is getting too severe," notes D.K. Chung, manager of original equipment manufacturing (OEM) sales for Samsung Electronics America Inc. in Rancho Dominguez, Calif. Samsung is the No. 1 monochrome monitor supplier, shipping some 2 million units in 1985, according to Stanford Resources Inc.

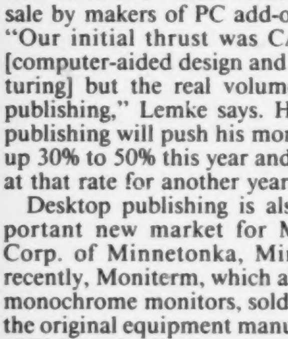
The "Four Tigers" of the Far East — Hong Kong, Singapore, South Korea and Taiwan — "created two, three times more in supply than what there was demand for," agrees David Lindstrom, president of Elston Electronics Corp., a leading OEM monitor supplier in Geneva, N.Y. "Nobody's making any money."

Even a giant like Hitachi Ltd. has moved away from the monochrome business to concentrate on higher margin color products, according to Thomas Klopcic, a marketing manager for Hitachi America Ltd.'s Electron Tube division in Schaumburg, Ill.

But Lindstrom hopes that he can boost Elston's business by doing short runs of custom monitors for U.S. systems integrators. He has almost convinced Vollum of E-Machines, who says he is considering Elston as a supplier. E-Machines has to rearrange the circuitry in the Panasonic monitor to fit Apple's Macintosh, which means it has to void the Panasonic warranty. "That's a problem with Panasonic — they absolutely won't customize for you," Vollum says.

DAVID CARD

Monochrome monitors



Worldwide production by region
(millions of units)

Region	1986	1987	1990
United States	1.7	1.9	2.4
Europe	0.9	1.0	1.2
Japan	2.4	2.6	3.2
Far East and others	9.5	10.1	13.1
Total	14.5	15.6	19.9

Worldwide consumption for computers
(thousands of units)

Resolution	1986	1987	1990
Low/medium	9,902	10,695	13,464
High/ultra-high	143	223	517
Total	10,045	10,918	13,981

Source: Stanford Resources Inc.

Hardware vendors adapt to a changing E-mail market

The $300 million electronic mail market is in flux, thanks to the emergence of a new standard: X.400

The U.S. market for electronic mail software and services — currently pegged at approximately $300 million — is about to experience a major shake-up, and possibly shakeout, thanks to a new standard known as X.400.

So far, however, vendors seem unsure what to do with X.400 — the universal E-mail interface which is part of the Open System Interconnection (OSI) data-interchange standard being hammered out by various national and international standards groups. All of them are at least monitoring developments connected with the evolution of the standard, a final version of which is undergoing review by a National Bureau of Standards committee. But to date, few have announced products which integrate or incorporate X.400. In part, companies say, they are holding off from announcing this capability so they can make sure their products are 100% compatible with the final version of X.400. IBM has announced, however, that it plans to offer a software program called X.400 Message Transfer Facility Program Offering, but it won't be available until the third quarter of 1988 and then only in Europe.

But some E-mail firms also acknowledge that adoption of X.400, at least in theory, will enable unlimited access to competing E-mail services. Currently, customers choosing one vendor's product are locked into sharing information with customers and services which are part of that vendor's network. With unlimited access, "some competitors may feel they have very little to gain and a lot to lose," says Eric Arnum, editor of the "Electronic Mail and Microsystems" newsletter published by the Norwalk, Conn., market research firm, International Resource Development Inc.

"There's already a reluctance to share customer lists," Arnum explains. "Some companies fear their directories could become sales lists."

However, this fear has not stopped vendors — especially the public, or nonproprietary E-mail companies, such as CompuServe Inc., MCI Communications Corp., Western Union and others — from developing specific interfaces to individual (and many times directly competing) E-mail products. Western Union, for one, has developed interfaces between its EasyLink service and various proprietary E-mail products offered by Digital Equipment Corp., IBM and Wang Laboratories Inc., public E-mail networks in France and Japan, and the Telex network worldwide. Talks between Western Union and other public vendors about developing direct interfaces to their services continue "from time to time," adds Joseph Norton, assistant vice president of EasyLink product development for the Upper Saddle River, New Jersey-based company. It's more emotion than technology holding up their progress, he admits.

It's easy to justify costs with E-mail

Marty Braun

A growing number of private (or proprietary) vendors, too, are dabbling in interfaces between their products and other public and private E-mail facilities, especially IBM's Professional Office System (PROFS) and Distributed Office Support System (DISOSS).

Connectivity concerns

But E-mail companies hardly are providing these interfaces out of the goodness of their hearts. Customers are demanding connectivity. And in E-mail, when the customers talk, vendors listen — primarily because vendors have been largely unsuccessful in generating the widespread interest they originally anticipated.

"It's very easy to justify costs and benefits for E-mail, but companies still acknowledge they're having trouble selling it," says Krystyna Filistowicz, a research analyst for San Jose, California's Dataquest Inc. The lack of universal data-interchange standards is only partially to blame, she says. The failure by top management at many big corporations to decree implementation company-wide has also contributed to E-mail's limited success, she claims.

This top-down, corporate-wide mentality also explains why the biggest E-mail vendors continue to be the top computer vendors, which tend to offer E-mail as an inseparable part of their general office-automation software. IBM, with an installed base of 4,000 PROFS and DISOSS packages combined, is the leader, according to Arnum, followed by DEC, with 3,800 All-In-1 packages installed. Then comes Data General Corp., with 3,000 installed copies of its CEO product line. (Each of these installed packages represents multiple users, usually in the range of 30 or more.)

At least 35 to 40 U.S. computer and independent software vendors sell some type of E-mail integrated with other office-type software, Arnum estimates. With average prices for these total office-automation packages in the tens of thousands of dollars range, the E-mail portion of their sales should total about $100 million in 1987, he says.

Revenue of the 14 top U.S. public (or nonproprietary) E-mail vendors, on the other hand, should reach $270 million this year, Arnum says. These companies charge their customers a small fee (usually $1 or so) for each message they send, plus some type of annual user fee. Arnum cites Western Union's EasyLink as the largest public vendor transmitting seven million messages per month, followed by US Sprint/Telenet's Telemail at 2.2 million messages, and then MCI's MCI Mail at two million messages.

Homegrown E-mail systems are disappearing

Marty Braun

X.400 impact

There is little current competition among the computer vendors, independent software vendors and public network vendors. "We can sell and market E-mail to death, but we won't change the economics of company decisions to go in house or public," confirms Western Union's Norton. Adds Shearon Arnott, director of information center product marketing for Applied Data Research Inc., a Princeton, N.J., database software and E-mail vendor owned by Ameritech: "IBM dominates this market, no matter how you cut it. And IBM doesn't give up market share very easily." Consequently, *Fortune* 500 companies have tended to be the almost exclusive domain of the private E-mail vendors, while the medium- and smaller-sized firms have typically gone with public E-mail vendors.

But with X.400 a lot of these givens could change, industry watchers say. In fact, a number of E-mail vendors already are gearing up for a more competitive marketplace. "More people are finding ways to justify E-mail for different reasons," says ADR's Arnott. "The market's growing. Companies that had homegrown E-mail systems are outgrowing them." In order to make its ADR/eMail product more appealing to users outside of its database management-software customer base, ADR recently introduced an interface to IBM's DISOSS program. By the end of the year, the company intends to introduce an interface to DEC's All-In-1, Arnott says, followed by similar ones to Wang, MCI Mail, Telex, and other data-interchange systems. At the same time, ADR is working to expand the breadth of its E-mail offering.

Meanwhile, Western Union is not resting on its laurels. The No. 1 public vendor plans to offer complete capabilities for X.400-compatibility by the end of 1987, Norton says. Sometime in the second quarter, EasyLink users will be able to transmit and receive binary-code files, including spreadsheets, databases, and other complete computer programs. It also plans to expand its current domestic facsimile delivery capability to a worldwide capability by the second quarter, Norton says.

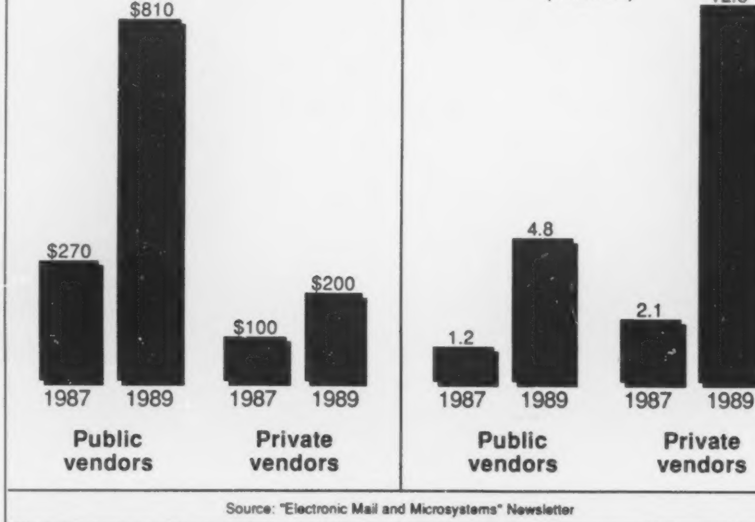
Computer vendors, too, are scrambling. Wang introduced its first standalone E-mail product, Wang Office Mail, in January. The product is geared toward smaller companies, for which an electronic mail-only product is most easily cost justifiable, says Jackie Appel, manager of office applications product marketing.

Wang also is continuing to enhance the E-mail capabilities contained within its Wang Office integrated software, as well as its E-mail component of PC Office. As part of this strategy, Appel says, the company is further developing its integration capabilites — especially E-mail/voice mail integration. And, like other public and private E-mail vendors, Wang is developing links to other E-mail services. So far, it provides links to IBM's PROFS and DISOSS only. But through its third-party integration program, it is encouraging other vendors to employ its Application Program Interface subroutines to build links to Wang Office, she points out.

More than ever before, "customers are looking for a backbone to their office systems," Appel concludes. "E-mail is that backbone."

MARY JO FOLEY

U.S. electronic mail market



Source: "Electronic Mail and Microsystems" Newsletter

IC equipment makers get down to business

The equipment industry is emerging from the recession with a new respect for the art of business and customer needs

By Mark Mehler

The $5 billion worldwide semiconductor equipment industry is emerging from the mire of a three-year recession wiser, trimmer and cognizant of its casualties, and determined to balance technological striving with good business practices. Now, if only the chip makers would start buying equipment again.

The semiconductor merchant vendors spent $1.685 billion on semiconductor-related capital expenditures in 1986, which represented a 21% decline from 1985's $2.125 billion, according to market researchers at Integrated Circuit Engineering Corp. in Scottsdale, Ariz. The researchers contend that each capital equipment dollar invested yields about $2 in additional annual sales for the chip makers.

U.S. chip makers are also concerned with the future of their supplier base and some are calling for a new era of good feeling. "We are opening up our kimono," says Keith Erickson, director of materials for Intel Corp. Intel has been singled out by vendors for putting them through endless evaluations and for publicly praising Japanese equipment. Erickson says Intel hopes to end the "adversarial" relationship by forming tighter bonds with suppliers and doing whatever is feasible to shorten the pipeline and improve communications to avoid inventory problems caused by order cancellations. "The equipment suppliers did what we told them in [1984] and they got hurt," says Erickson. "We don't want that to happen again."

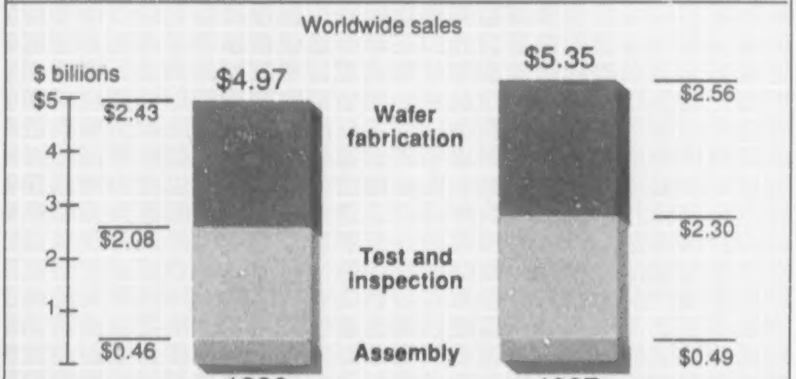
Mohan Rao, senior vice president at Texas Instruments Inc.'s Semiconductor Group, likewise calls for closer vendor-user relationships, noting historically, the equipment maker "hasn't been an integral part of the development of the process." Nevertheless, Rao envisions an inevitable shakeout among U.S. equipment companies that can't fund development of flexible systems. "The equipment industry needs an infrastructure," he says. "And we would like to see a reduction in redundancy."

Chip makers have also taken the initiative in the proposed Sematech manufacturing technology consortium that has embraced the concept of pursuing semiconductor manufacturing technology through a combined industry and government-sponsored research organization.

It may be difficult to find the silver lining in this market, but it does exist. There remains an astounding wealth of good semiconductor process technology and products among the estimated 2,500 worldwide suppliers of equipment and materials. Neither technical innovation nor the nerve to take risks is in short supply. What has contributed most to the IC equipment industry's three-year malaise is a breakdown in good business practices: poor balance sheets, inattention to customers' needs, faulty market forecasting, bad product marketing, and plain old-fashioned arrogance. Nearly every vendor owns up to these failures over the past 10 years and blames them for the present sorry state of the industry.

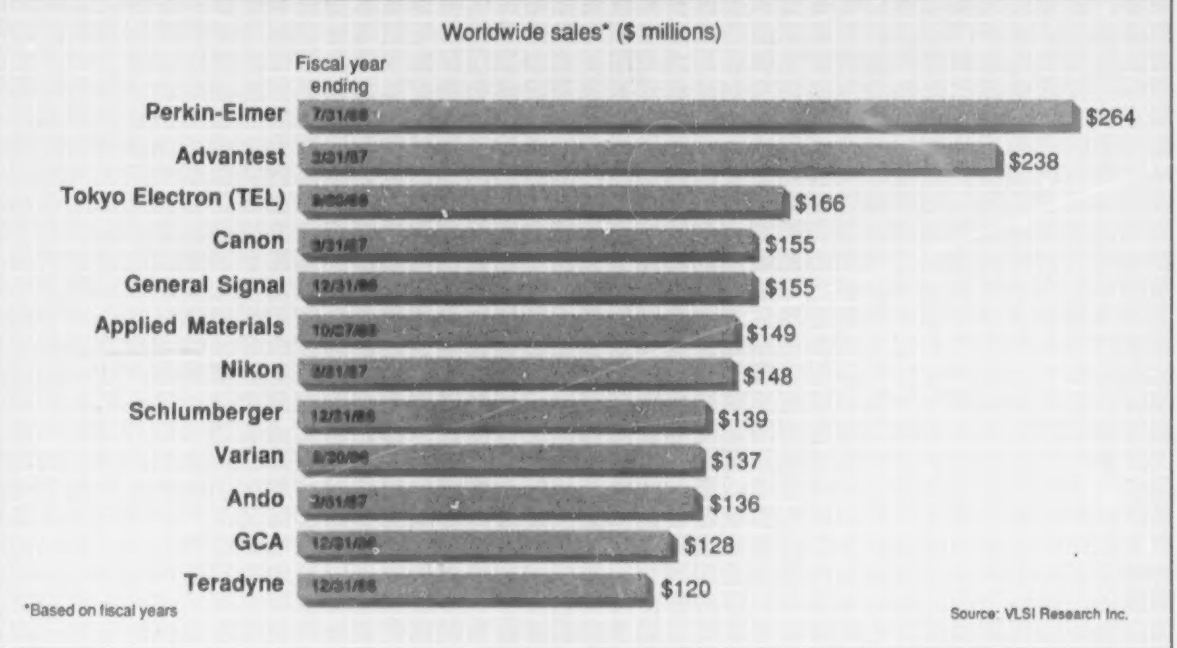
But, the equipment makers are by no means entirely responsible for the grim situation. Their customers, the chip makers that fuel the boom-and-bust cycle with their unpredictable ordering patterns and their lack of cooperation with suppliers, are heavily at fault. And there are basic structural business problems in the semiconductor industry itself, which are

Semiconductor production equipment market



Source: VLSI Research Inc.

Top semiconductor equipment manufacturers



*Based on fiscal years

Source: VLSI Research Inc.

nobody's fault but nevertheless require a lot more attention from users and vendors.

The ultimate irony

"We've been saying it for years, you've got to run a business along responsible financial lines," says G. Daniel Hutcheson, president of VLSI Research Inc., a Silicon Valley consulting firm. "Unfortunately, everybody's off chasing technology trying to leapfrog the next person, and costs have risen beyond their ability to pay for it. The ultimate irony is that U.S. users keep demanding new leading-edge technologies and when they see the bill they won't pay for it. Technology is like bread. If it isn't supported by a viable business plan, it goes stale."

Industry observers believe that what will eventually pull the U.S. survivors through the recession are not grandiose technological innovations — such as larger silicon wafer sizes and complex automation schemes — government funding, or cooperative research and development projects, but a transition from a technology-driven to a cost-driven industry. Such a move would make it possible to compete with an aggressive Japanese production equipment effort.

Indeed, the three-year recession did give Japanese equipment vendors, that are closely tied to giant semiconductor companies in Japan, either through ownership or tight partnership, a leg up in this country. In the equipment segments targeted by Japan, it has made significant market share gains. Dataquest estimates that the Japanese share of the optical lithography market in the United States rose from 1% in 1983 to 28% in 1985, with Nikon Precision Inc. having 23% and Canon U.S.A. Inc., 5%. In dry-etching equipment, Japanese sales here went from zero in 1983 to 5% in 1985 — $8 million of a $170 million market. In electron beam photomask-making equipment and in scanning electron microscopes, the Japanese also picked up sizable market share here, says Dataquest.

Alexander Cutler, president of Eaton Corp.'s Industrial Group, a leader in ion implantation equipment, notes that it has always been the onset of next-generation chips that has pulled the equipment industry out of recession. Development costs, meanwhile, kept rising, and equipment prices skyrocketed as a result. Today it can take up to $30 million to bring an advanced lithography, implant, or test system to market. A single piece of gear can cost upward of $2 million. "That cycle is coming to an end as the industry evolves from an entrepreneurial to a mature environment," Cutler explains. "It's a natural evolution and you're seeing a lot of companies recognizing the importance of better business management."

> **"We had a high-risk strategy of trying to throw money at these projects to make a technological breakthrough that would give us market position. It didn't pan out and the only thing to do was fold it"**
>
> **Alexander Cutler, president of Eaton Corp.'s Industrial Group**

Eaton itself, according to Cutler, recognized that transition late last year when it closed most of its semiconductor equipment lines, including wafer steppers (which expose circuits on a wafer) and automatic test equipment. "We had a high-risk strategy of trying to throw money at these projects to make a technological breakthrough that would give us market position. It didn't pan out and the only thing to do was fold it."

Among other large multiproduct semiconductor equipment firms, the same realization has taken hold. Perkin-Elmer Corp., the company that led the market last year with more than $260 million in sales, and is the market leader in the microlithography segment, has focused resources on its mainstream optical and electron-beam wafer exposure machines and backed out of the plasma-etching and metal deposition equipment segments. Veeco Instruments Inc. recently pulled the plug on its ion implant business, in which it had never gained significant market share, to concentrate on its existing niches in semiconductor instruments and automatic guided vehicles for process automation.

"I wish back in 1984 somebody had told me about 1986"

Arthur del Prado, president, ASM

"We're trying to get back to areas where we have a No. 1 or 2 position, even if the markets are tiny," insists Edward Braun, executive vice president of Melville, New York-based Veeco, which has a $40 million annual business in semiconductor-related gear. "We've finally recognized you can't afford to be the No. 5 company in a $150 million market where it costs tens of millions to bring out a product. Yes, we're going to be a lot more conservative to remain a bottom line company. You'll see many other divestitures throughout the industry for the same reason."

Horace McDonell, chairman and chief executive of Norwalk, Connecticut-based Perkin-Elmer, suggests equipment makers were too quick to "believe their own publicity" after the big growth spurt that saw worldwide industry revenue soar from $3.34 billion in 1983 to $6.3 billion in 1984. "Our goals were unrealistic," says McDonell. "But I'm proud that we were among the first to say that the king has no clothes."

High marks for PE

Nearly three years ago Perkin-Elmer began to contain costs and reduce levels of management and staffing across the entire company (PE is a major player in the analytical instrument and government markets), because it believed that profit margins were not keeping pace with sales gains. Last year, the Semiconductor Equipment Group earned $21.4 million, nearly 9% of net sales. A January charge relating to a write-off of etching equipment clouds the profit picture for this year, but analysts credit PE with superb balance sheet management. Where they are critical is in the company's shifting key resources from its successful lithography business (projection mask aligners and electron-beam equipment) to support a struggling plasma systems business, and in PE's failure to recognize critical marketing trends.

For example, the company had the opportunity in the late 1970s to get into the wafer stepper business. At the time, PE had only projection aligners, which expose an entire wafer at one time (whereas steppers expose wafers by "stepping" from die to die). Steppers have since supplanted projection machines at many fabrication plants and PE didn't enter that market until it bought a European manufacturer, Censor, in 1984. PE's share of the worldwide stepper market in 1986 was only 15%, according to VLSI Research.

McDonell confesses to errors in judgment ("management without error is a contradiction in terms," he says), specifically giving the marketing side of Perkin-Elmer short shrift. "Our history suggests that technology is where we excel," concludes the PE chairman. "But there are new realities. Because we're smart in one field doesn't mean we're smart in another. We're going to run our business with an element of restraint and not get caught up in the kind of euphoria that saw 50 companies in the etch business [go under] . . . at least we haven't hit the financial wall."

"We've finally recognized you can't afford to be the No. 5 company in a $150 million market where it costs tens of millions to bring out a product"

Edward Braun, executive vice president, Veeco Instruments

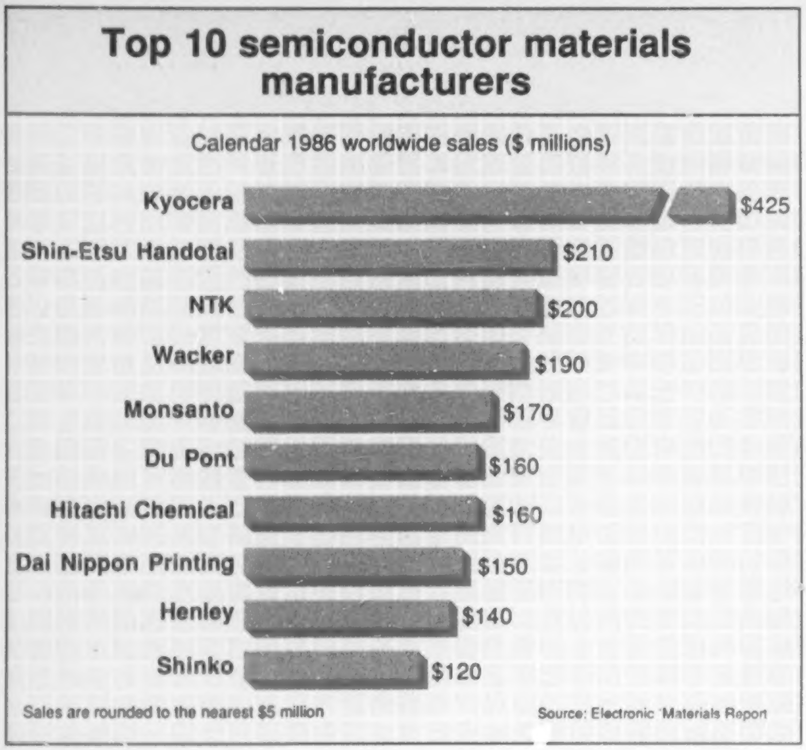
Would that other major equipment suppliers could say the same, but a large number are so pressed for cash that a further delay in the anticipated industry recovery, beyond 1987, could be disastrous.

Advanced Semiconductor Materials International Inc., a Netherlands-based public firm, is one example of a relatively small company (its 1986 sales, not yet reported, will be about $150 million) that is sitting with some very attractive technologies and some serious balance sheet woes. As of Sept. 30, 1986, ASM had a bulging debt-to-equity ratio of 0.86:1, after three consecutive years of losses. For the nine months ended in September, the company lost $22 million on sales of $105 million. Essentially, the company got caught in a double squeeze. While it was expanding through acquisition and internal development into three major new markets — ion implant, epitaxial reactors for complementary metal-oxide (CMOS) chips, and wafer steppers — the public equity markets were drying up, forcing the firm to take on a heavy debt load.

"It was terrible timing," says a former ASM executive. "Obviously it would make more sense to issue stock and perhaps their financial management was wrong, but strategically they were right. They have excellent products which technologically have the chance to give them strong market share, and they have solid global objectives. But will they survive is the big question."

Arthur del Prado, the peripatetic president of ASM, whose mainstream businesses are IC assembly equipment and chemical vapor deposition systems, calls 1987 the "survival year," acknowledging that he is nervous about his company's finances. However, del Prado expects an infusion of additional cash, partially in the form of new bank debt, which he believes will see the company through until its new products are established in the marketplace. "We can manage," he says. "But I wish back in 1984 somebody had told me about 1986. We extended more than we were ready for."

Indeed, the failure of the equipment industry to forecast the downturn was probably the single biggest reason for its current problems. Sadly, bad forecasting is largely a structural problem, endemic to the semiconductor business. In essence, semiconductor manufacturers and their vendors operate on widely different cycles. The chip maker plans his business three months ahead with only a one-month firm commitment on purchases, while the equipment vendor is on a six-month cycle. The equipment supplier must begin ordering inventory and putting it through the manufacturing pipeline



Top 10 semiconductor materials manufacturers

Calendar 1986 worldwide sales ($ millions)

Sales are rounded to the nearest $5 million

Source: Electronic Materials Report

six months before shipment. In 1985, when so many semiconductor houses cancelled or stretched out their orders for equipment, their suppliers were stuck with millions of dollars in work-in-process inventory and couldn't shut off the flow.

Nevertheless, a number of equipment vendors that suffered through the inventory headache are finding creative ways to forecast more effectively. Kulicke & Soffa Industries Inc., a Willow Grove, Pa., manufacturer of assembly equipment, saw its sales plummet from $125 million in fiscal 1985 (ended in September) to about $60 million last year. Donald VanLuvanee, a former manager at Texas Instruments Inc. who has been K&S president since the downturn's start, says the company was in close contact with major customers and relied heavily on customer data to formulate K&S's business plan. "We were guilty of not developing our own forecasting tools . . . . If I believe the market is going to grow to three times its present size by 1990, I have the responsibility to critically judge that forecast because we simply don't have the ability to protect our backlog."

K&S is currently creating its own forecasting models, compiling its own data on such issues as factory utilization and spare parts usage. For example, last spring many in the industry were heralding an upturn. "Had we carefully tracked the spares business," says VanLuvanee, "we would have seen last May that all the users were doing was cannibalizing old machines to [retrofit new ones]."

GCA Corp., a manufacturer of wafer steppers in Andover, Mass., was nearly driven out of business by poor forecasting. While the worldwide stepper market in 1985 was collapsing, falling 25% from $543 million to $408 million, GCA was ramping up to increase sales from about 300 machines to 500 machines and hoped to compete not only in steppers, but in advanced robotics and factory automation systems. Marketing managers, who petitioned top management to scale back its forecasts, were reportedly ignored. GCA, which owned the stepper market in the early 1980s, shipped barely 100 systems in 1985. Today, the company has a negative net worth of $12 million, after losing more than $100 million over the past two years. Present management, which was brought in to rescue the stepper maker, describes the situation as a "mess."

Peter Simone, president of the beleaguered company, says GCA's financial plight has forced it to take a harder look at its mainstream market. "We've got to look at the market with some level of reality. We know a big year will be: 600 units shipped worldwide." In that vein, GCA is trying to get a handle on its inventories and costs. "To deal with the problem of cyclicality," Simone adds, "we've begun making more of a commitment to our own suppliers . . . . We pay a lot more attention to our vendors, and in one critical manufacturing area, lenses, we have Tropel, our own company, supplying our requirement." Simone says longer term, sole-source arrangements with suppliers will allow GCA to be more flexible in responding to order cutbacks. Meanwhile, with an upcoming rights offering and an equity placement expected to raise a total of $72 million, GCA officials believe they will have enough resources to carry their new Model 8500 stepper to market. Several industry analysts think GCA has worked many of the bugs out of its system and could be a formidable competitor once again. Simone says GCA simply needs to establish "credibility" with its customers to get back in the game.

Still another major problem for vendors in the recession: how to take some of the enormous costs out of research and development. John Halter, senior vice president for operations for General Signal's IC equipment business, sees this as crucial to the survival of his group of small systems houses. GS basically operates its 19 semiconductor equipment and materials companies as autonomous entities. R&D costs, says Halter, must be spread throughout the entire organization to realize economies of scale. "We can't afford so much duplication of effort," he says. GS in the last year has changed other elements of its IC equipment strategy. Where once it had hoped to be the "one-stop shop" for all equipment needs, today Halter acknowledges that the cost of trying to be all things to all people is too high. Advises Halter, "You can't operate like a discount department store. We are specialists."

In 1983-1984, when larger equip-

> **"Had we carefully tracked the spares business, we would have seen last May that all the users were doing was cannibalizing old machines to [retrofit new ones]"**
>
> **Donald VanLuvanee, president, Kulicke & Soffa**

ment companies were eyeing massive diversification into new markets, General Signal's laissez-faire management style was roundly criticized. In the current environment, industry observers suggest GS's organization may be more in tune with what the market really requires: flexibility. Notes VLSI Research's president Daniel Hutcheson, "The big equipment companies, like Eaton, made two classic mistakes a few years ago. They were slow to make decisions and adopted big company management styles to run a cottage industry."

George Rutland, the president of Ultratech Stepper, one of General Signal's larger equipment units, concurs. "You really can't find any multiproduct equipment company now that is benefiting from being heavily centralized. If we had to appeal to corporate in Connecticut every time we made a decision, we couldn't react fast enough. Bigness brings complexity and can cause you to lose your focus."

Applied Materials Inc., one of the more successful semiconductor equipment makers during the recession — it earned $9.3 million on sales of $175 million in 1985 — made that mistake in the early 1980s when it tried to expand into the wafer exposure market through the acquisition of Computervision's Cobilt division. However, the mistake turned into a godsend. The manufacturing space that Applied acquired from Cobilt allowed the maker of etching, implant and epitaxial equipment to meet demand during the 1983-1984 frenzy. Today, according to president James Morgan, Applied is playing it closer to the vest, diversifying into thin film processing technologies where it can leverage its experience in automation and in reducing contamination.

> **"Our goals were unrealistic . . . but we were among the first to say that the king has no clothes"**
>
> Horace McDonell, chairman, Perkin-Elmer

Morgan talks about the need to design products for manufacturability, a problem that has plagued many in the industry. "Everything has to work in sync," he says. "You need reasonable specifications, good design engineering aimed at producibility, and working together with your materials management, forecasting and marketing." Morgan notes that in a market like dry etch equipment, populated by 40 or 50 vendors, product differentiation is absolutely essential. Applied's first etch system, when it was introduced in 1981, brought an entirely new batch processing technology to the market. "A lot of companies exhibited some very bad business judgment in their product marketing strategies," he concludes.

In addition to undifferentiated products, analysts cite other common mistakes: making formal product an-

Meeting your customers halfway

Two years ago, Advanced Micro Devices Inc. chief executive Jerry Sanders threw the book at his American equipment suppliers in a much-publicized speech in Texas. Sanders accused IC equipment makers of shipping unreliable products and providing poor support. The speech was a watershed in the equipment industry, prompting many systems houses to question their business practices. Today, suppliers say they have made great strides in improving quality and they challenge their customers to meet them halfway — to put their money where their mouth is.

"In Japan, semiconductor companies have recognized the strategic importance of their suppliers, and they are willing to invest in them, like NEC in Nikon," says Daniel Hutcheson of VLSI Research Inc. "But you don't see TI or Motorola doing the same with their U.S. suppliers, nor do you see U.S. companies investing in new technology. In 1980 and 1981 when GCA was breaking through with wafer stepper technology, 60% of their sales were in Japan. Then semiconductor people here scratch their heads and ask what is happening to our technology base."

Hutcheson says U.S. device makers have pushed their suppliers to build advanced equipment and neglected basics like safe operation and ease of use. "The equipment grew more inflexible and complex and users only talked about wanting something flashy, a new Ferrari with a V-12. What they needed, but wouldn't talk about, is a Toyota with seats in the back."

Equipment makers further accuse their customers of the following: subjecting vendors to drawn-out and ultimately fruitless product evaluations; preventing their vendors from playing a role in implementing the process on the shop floor; and paying lip service to "buy American" while purchasing Japanese products on the basis of lower price.

"Jerry Sanders was playing a card," says John Halter, senior vice president for General Signal Corp.'s semiconductor equipment unit, voicing a common complaint. "We ship a vanilla machine which the user takes and modifies for his own process. When he's through, you couldn't recognize the system. A year later, he tells you your equipment doesn't work."

Jonathan Golovin, president of Consilium Associates Inc., a maker of computer-integrated manufacturing software, says it is impossible for equipment companies to continue funding new products without assurance that customers will share the cost. He says long-term business relationships between vendor and user are one solution, but adds, "A major restructuring is going on, which is shrinking the number of people we sell to. Our semiconductor customers in this environment are in no rush to spend."

Some U.S. IC makers are beginning to respond to equipment makers' demands. Intel Corp., for example, has launched a "supplier motivation program," and its goal is to shift the focus off the giant technology breakthrough and toward improving system uptime, throughput and yield. Keith Erickson, director of materials for Intel, admits that the company has pushed new technology and neglected these essentials. Specifically, Intel has been in the forefront of the drive to six-inch wafers. Now, says Erickson, "We'd like to see someone else move it to eight inch." He adds that under the new supplier program, it is likely Intel will have to provide some "guarantees" on future equipment purchases. ☐

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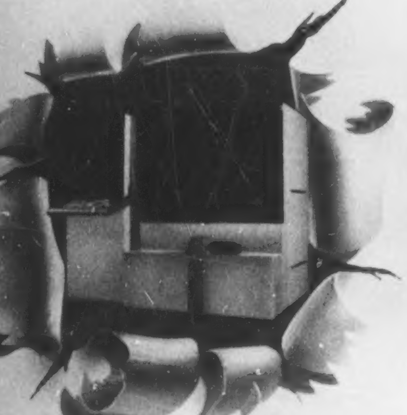

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nouncements months or years before the product has even gone through systems integration, let alone beta siting; and rushing in with new technologies that are years ahead of the market. The areas of direct-write electron-beam and X-ray lithography — techniques for exposing circuits on wafers using focused electrons and X-rays — are classic examples. A number of companies, including General Signal, Micronix Corp., Perkin-Elmer and Varian Associates spent vast sums bringing these advanced systems to market, while manufacturers of wafer steppers were extending the limits of their optical technology below one micron. Those gains in stepper performance have pushed the market window for X-ray and electron-beam out to the 1990s.

On top of this, U.S. equipment makers concede their systems are often not fit for use, compared with the process equipment of their Japanese competitors. This is a long-standing source of complaints within the user community. Kulicke & Soffa's VanLuvanee offers the following analogy: Japanese and American wristwatches, equally well made, but only the Japanese watch is designed for underwater use. "If you ever find yourself in a swimming pool," he says, "only the Japanese product will work. Their [wafer processing] equipment isn't necessarily better, but it's designed to be plugged in and operational in production."

Nevertheless, the recession in the Japanese semiconductor market — users there put a halt to capital equipment purchases two years ago — has likewise devastated Japanese equipment vendors. "If Nikon were a U.S. company," argues Gary Hillman, president of Machine Technology Inc., a U.S. supplier of photoresist processing equipment, "they'd be in as big trouble as their American competitors. We never talk about that, we just flagellate ourselves. But the fact is the Japanese market is in terrible shape, they still primarily get our technology and copy it, and we're much more active in their market than they are in ours."

> **"We've got to look at the market with some level of reality"**
> Peter Simone, president, GCA

In fact, there are indications that Japanese equipment vendors in this country are beginning to focus less on gaining market share at any price and more on fundamental business issues. A source close to Nikon Precision says "they are restructuring with an idea not to go after market share but work harder on their existing service organization." Michael Powell, newly named marketing manager at Nikon Precision, denies the company is scaling back its stepper marketing program here, but he notes the company is trying to expand its stepper image-processing technology into such new markets as flat panel displays and printed circuit boards. In so doing, Nikon is following the lead of such American firms as Consilium Associates Inc. and KLA Instruments Corp., which have decided to use their semiconductor technology as a wedge into new industries.

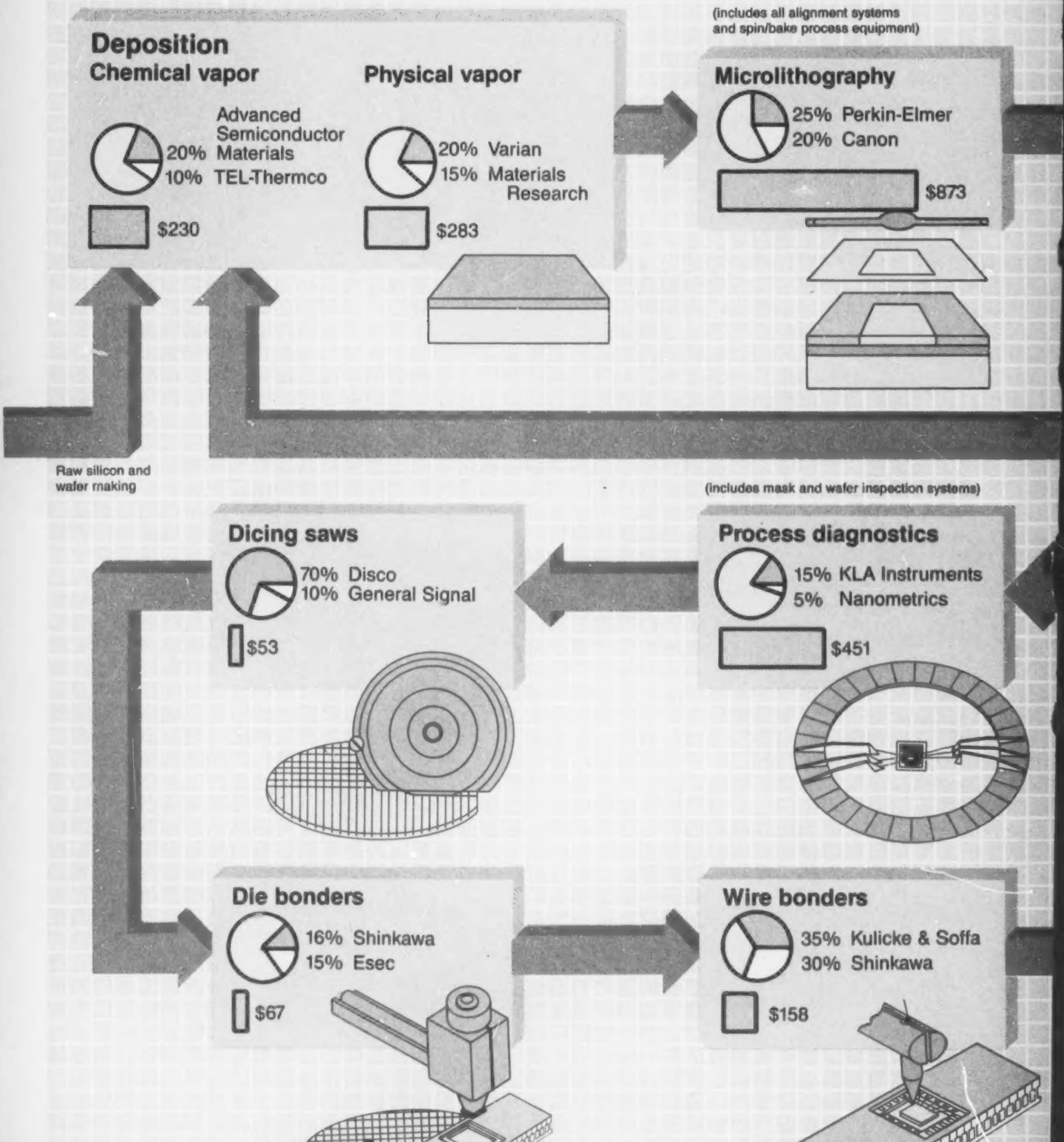
A tighter organization

Canon, meanwhile, has also tightened its organization in the recession. The stepper maker, which also produces copiers, cameras and other products, was aggressive in going after U.S. market share, reportedly installing more than half of its U.S. machines on a consignment, rather than on a sales, basis. "Everything we build now is on order," says a Canon source, who asked not to be identified. "We are also trying to forecast demand better and not build inventory. But it's like the old saying, 'Forecasting next year's sales is like the fire chief telling the mayor which houses will be on fire next year.' Managing our business is tough."

Stephen Balog, an analyst at Prudential Bache Inc., sees the Japanese suffering in the automatic test equipment business, as well, noting that Advantest Corp.'s sales are off 44% (in yen) in the first half of its fiscal year, ended last September. "No doubt about it, the Japanese are getting hammered all over," he says. "Nikon isn't what it used to be, they're pulling back. But the problems of a lot of smaller U.S. companies are much worse. You can't run debt up to your eyelids and carry big losses year after year. We are looking at one more year of hell. The tanks are empty and there's still a whole lap to go. When I look at all the smaller companies in deep trouble and the bigger companies who can't keep compromising the rest of their profits, I see a semiconductor equipment industry that's in big trouble structurally." ☐

Semiconductor fabrication

Equipment markets and leaders



Deposition

Chemical vapor

20% Advanced Semiconductor Materials
10% TEL-Thermco
$230

Physical vapor

20% Varian
15% Materials Research
$283

(includes all alignment systems and spin/bake process equipment)

Microlithography

25% Perkin-Elmer
20% Canon
$873

Raw silicon and wafer making

(includes mask and wafer inspection systems)

Process diagnostics

15% KLA Instruments
5% Nanometrics
$451

Dicing saws

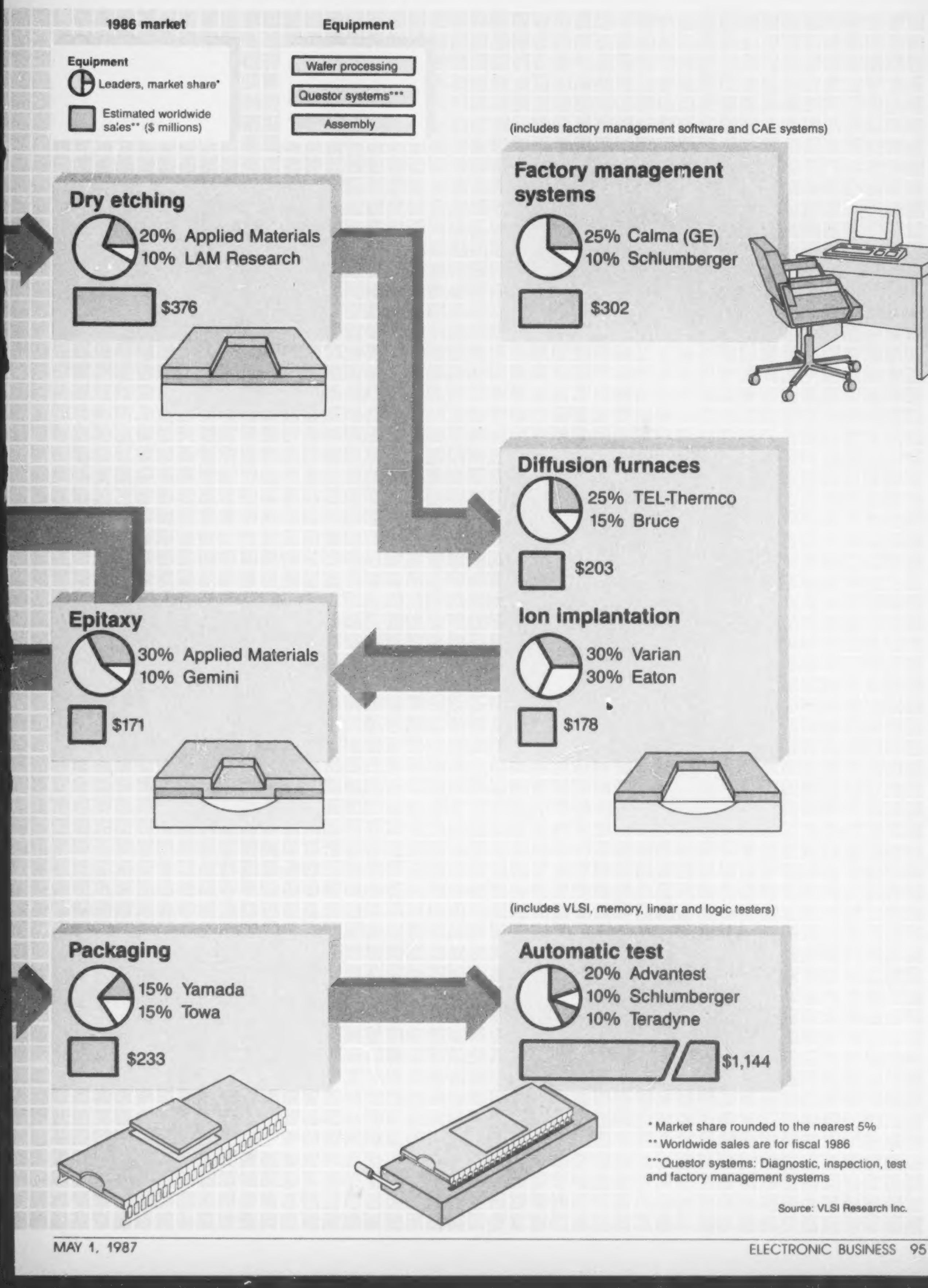
70% Disco
10% General Signal
$53

Die bonders

16% Shinkawa
15% Esec
$67

Wire bonders

35% Kulicke & Soffa
30% Shinkawa
$158



1986 market

Equipment
- Leaders, market share*
- Estimated worldwide sales** ($ millions)

Equipment
- Wafer processing
- Questor systems***
- Assembly

Dry etching
20% Applied Materials
10% LAM Research
$376

(includes factory management software and CAE systems)

Factory management systems
25% Calma (GE)
10% Schlumberger
$302

Diffusion furnaces
25% TEL-Thermco
15% Bruce
$203

Ion implantation
30% Varian
30% Eaton
$178

Epitaxy
30% Applied Materials
10% Gemini
$171

(includes VLSI, memory, linear and logic testers)

Packaging
15% Yamada
15% Towa
$233

Automatic test
20% Advantest
10% Schlumberger
10% Teradyne
$1,144

* Market share rounded to the nearest 5%
** Worldwide sales are for fiscal 1986
***Questor systems: Diagnostic, inspection, test and factory management systems

Source: VLSI Research Inc.

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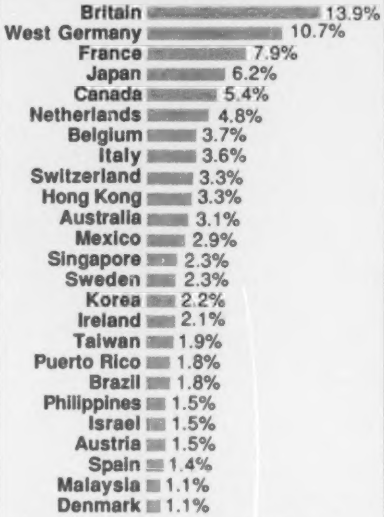
Top 25 most commonly selected areas for international plant sites and facilities

Percentage of respondents to AEA survey



Figures are derived from a 1984 survey of the American Electronics Association's 2,700 member companies. Over 270 companies responded, giving the survey a 10% response rate.

Source: American Electronics Association

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Fastest growing firms: Life in the fast lane

On average, lead U.S. disk drive supplier sales surged 33% over the past five years

By Al Furst and Linda Stallmann

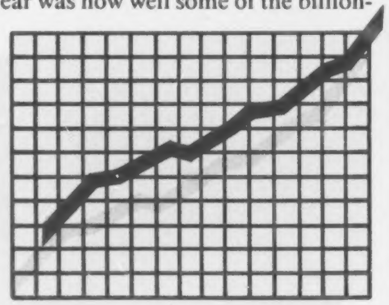
Riding the crest of the wave in distributed computing, which swept across the United States in the first half of this decade, the fastest-growing disk drive makers and other peripherals manufacturers recorded a torrid 33.8% compound annual growth rate from fiscal 1981 to 1986.

Our annual analysis of the 100 fastest growing companies in the United States also showed that four of the top 10 leaders in this category were disk drive makers — Miniscribe Corp. of Longmont, Colo., the fastest growing company overall which posted a phenomenal 369.5% five-year compounded growth rate; Seagate Technology of Scotts Valley, Calif., which clocked in at 115.9%; Priam Corp. of San Jose, Calif., at 84.7%; and Micropolis Corp. of Chatsworth, Calif., at 54.9%.

Also, with the exception of Priam, which recently experienced a $31 million write-off in excess equipment, all four of those companies also performed reasonably well in the most recent financial quarters, both from the standpoint of sales and profitability. Micropolis ended fiscal 1986 with $18.3 million in net profits, up from $2.7 million the previous year, on $213 million in sales, up from $94.9 million in 1985. Miniscribe posted year-end earnings of $22.7 million, up from a loss of $16.7 million the previous year, on sales of $184.9 million, which was up from $114 million in 1985. And in the first six months of fiscal 1987, ended Dec. 31, Seagate showed $62.1 million in earnings, versus $6.2 million for the comparable period in 1986, while sales soared to $440.9 million, from $191.3 million.

As with three-quarters of the companies we looked at in our top 100 list, all four of the disk drive companies also had sales of under $500 million during this period. This phenomenon — smaller companies growing at a more robust rate than larger ones — is not unusual because high-tech start-ups (starting from the ground up) usually have a more rapid ramp-up than the industry giants.

But what was also surprising this year was how well some of the billion-dollar companies performed over the past five years. Apple Computer Inc., which — last time we looked — was still a glamour stock on Wall Street, posted a 41.5% growth rate from 1981 to 1986; Wang Laboratories Inc., which has been battered in the past year by the computer slowdown, still managed a 25.3% growth rate; and Digital Computer Corp., which is increasingly stealing IBM's thunder — not to mention its sales and salesmen — notched up a respectable 18.9% compounded annual growth rate.



What was surprising was how well some of the billion-dollar companies performed

Other members of the billion-dollar clubs which made this year's fastest-growing list include Amp Inc., Data General Corp., E-Systems Inc., Harris Corp., Hewlett-Packard Co., IBM, Intel Corp., Motorola Inc., N.A. Philips Corp., Tandy Corp., Xerox and Zenith Electronics Corp. It is noteworthy, however, that newly formed Unisys Corp. — which grew out of the highly touted merger last year between Burroughs Corp. and Sperry Corp. — did not make the list this year. Unisys may be the second largest computer company in the United States, after IBM, but using sales over a five-year period as a measure of growth, the company did not measure up. In fact, Burroughs and Sperry on a prorated basis posted a 0.4% decline in growth over the five-year period under analysis.

In order for a firm to qualify for our annual list, it must meet four criteria: it must be a publicly held U.S.-based company; its 1986 revenue must total $100 million or more; its electronics revenue, as defined by our research staff, must make up at least 70% of total revenue (software and service firms are excluded, this is why Microsoft Corp. and AT&T never make our list); and it must have recorded at least five years worth of revenue.

This last criterion — five years of revenue — is the reason why our selections did not include companies in the number of red-hot industry areas, notably workstations and computer-aided engineering, which (with the possible exception of No. 3 ranked Apollo Computer Inc.) are conspicuously absent from our list. If the start-ups in those areas were included, as many no doubt will be next year, they — and not disk drive makers — would have probably topped our annual fastest growing list. □

Fastest growing companies

Rank	Company	Sales growth (5-year compounded annual rate)	Fiscal 1986 revenue ($ millions)	Fiscal 1986 profits ($ millions)	Fiscal year ended (month/year)	Location
1	**MiniScribe**	369.5%	$184.9	$22.7	12/86	Longmont, Colo.
2	**VLSI Technology**	189.1%	111.7	0.1	12/86	San Jose, Calif.
3	**Apollo Computer**	158.4%	391.7	9.3	12/86	Chelmsford, Mass.
4	**Seagate Technology**	115.9%	459.8	34.5	6/86	Scotts Valley, Calif.
5	**Convergent Technologies**	87.8%	305.8	-32.8	12/86	San Jose, Calif.
6	**Priam**	84.7%	128.8	0.1	6/86	San Jose, Calif.
7	**Digital Communications**	69.8%	137.9	20.6	6/86	Alpharetta, Ga.
8	**Western Digital**	63.5%	279.4	27.8	6/86	Irvine, Calif.
9	**Emulex**	59.9%	104.9	7.5	6/86	Costa Mesa, Calif.
10	**Micropolis**	54.9%	213.1	18.3	12/86	Chatsworth, Calif.
11	**DSC Communications**	53.5%	304.0	11.0	12/86	Plano, Texas
12	**SCI Systems**	51.3%	470.2	13.8	6/86	Huntsville, Ala.
13	**Xebec**	51.0%	115.5	-3.5	9/86	San Jose, Calif.
14	**Cipher Data Products**	48.2%	163.0	7.2	6/86	San Diego, Calif.
15	**Intelligent Systems**	46.2%	125.5	0.0	3/86	Norcross, Ga.
16	**Intergraph**	46.1%	605.7	70.4	12/86	Huntsville, Ala.
17	**Emerson Radio**	45.2%	566.3	12.9	3/86	North Bergen, N.J.
18	**Altos Computer Systems**	44.4%	134.2	20.3	6/86	San Jose, Calif.
19	**Xidex**	42.6%	432.3	32.2	6/86	Mountain View, Calif.
20	**Cray Research**	42.5%	596.7	124.8	12/86	Minneapolis, Minn.
21	**Cincinnati Microwave**	42.4%	102.1	11.5	12/86	Cincinnati, Ohio
22	**Apple Computer**	41.5%	1,901.9	154.0	9/86	Cupertino, Calif.
23	**Micom Systems**	39.1%	189.5	12.7	3/86	Simi Valley, Calif.
24	**ISC Systems**	38.7%	166.1	13.9	6/86	Spokane, Wash.
25	**NBI**	37.4%	282.4	-4.2	6/86	Boulder, Colo.
26	**Timeplex**	34.5%	119.1	9.6	6/86	Woodcliff Lake, N.J.
27	**Tandon**	31.6%	214.1	-62.8	9/86	Chatsworth, Calif.
28	**Decision Industries**	31.2%	195.1	7.8	11/86	Horsham, Pa.
29	**Telex**	30.6%	709.2	67.5	3/86	Tulsa, Okla.
30	**Tandem Computers**	29.8%	767.8	63.8	9/86	Cupertino, Calif.
31	**Bolt Beranek and Newman**	26.5%	178.0	11.3	6/86	Cambridge, Mass.
32	**Electrospace Systems**	26.1%	145.0	13.4	3/86	Richardson, Texas
33	**Computer Products**	26.0%	111.4	-9.3	12/86	Pompano Beach, Fla.
34	**General DataComm Industries**	25.3%	178.0	3.9	9/86	Middlebury, Conn.
35	**Wang Laboratories**	25.3%	2,643.0	50.9	6/86	Lowell, Mass.
36	**Dynatech**	25.1%	256.7	20.4	3/86	Burlington, Mass.
37	**Anthem Electronics**	23.6%	104.5	3.1	3/86	San Jose, Calif.
38	**Diasonics**	23.5%	217.1	5.9	12/86	Milpitas, Calif.
39	**Loral**	22.8%	663.8	53.0	3/86	New York, N.Y.
40	**Monolithic Memories**	21.8%	204.9	8.9	9/86	Santa Clara, Calif.
41	**Logicon**	21.2%	200.5	10.0	3/86	Torrance, Calif.
42	**Avantek**	20.5%	208.2	16.1	12/86	Santa Clara, Calif.
43	**Printronix**	20.3%	131.9	-11.7	3/86	Irvine, Calif.
44	**Key Tronic**	20.3%	111.7	0.6	6/86	Spokane, Wash.
45	**DEC**	18.9%	7,590.4	617.4	6/86	Maynard, Mass.
46	**Prime Computer**	18.7%	860.2	46.9	12/86	Natick, Mass.
47	**Evans-Sutherland**	18.7%	109.3	10.9	12/86	Salt Lake City, Utah
48	**Marshall Industries**	18.3%	244.8	2.9	5/86	El Monte, Calif.
49	**AEL Industries**	17.0%	104.9	4.7	2/86	Lansdale, Pa.
50	**Amdahl**	16.9%	966.3	41.8	12/86	Sunnyvale, Calif.

Source: ELECTRONIC BUSINESS

(Continued)

Fastest growing companies (continued)

Rank	Company	Sales growth (5-year compounded annual rate)	Fiscal 1986 revenue ($ millions)	Fiscal 1986 profits ($ millions)	Fiscal year ended (month/year)	Location
51	**Computer Consoles**	16.6%	$129.6	-$3.0	12/86	Waltham, Mass.
52	**Analog Devices**	16.4%	334.4	23.4	10/86	Norwood, Mass.
53	**Pioneer-Standard**	16.4%	202.0	-2.0	3/86	Cleveland, Ohio
54	**Data Card**	16.3%	153.6	10.6	3/86	Minneapolis, Minn.
55	**Nicolet Instruments**	15.9%	126.4	2.9	3/86	Madison, Wis.
56	**Gerber Scientific**	15.5%	191.8	18.2	4/86	South Windsor, Conn.
57	**Molex**	15.3%	291.9	32.0	6/86	Lisle, Ill.
58	**Adams-Russell Electronics**	15.2%	113.1	6.7	9/86	Waltham, Mass.
59	**Hewlett-Packard**	15.0%	7,102.0	516.0	10/86	Palo Alto, Calif.
60	**Coherent**	14.7%	138.2	1.7	9/86	Palo Alto, Calif.
61	**E-Systems**	14.7%	1,135.1	61.6	12/86	Dallas, Texas
62	**Watkins-Johnson**	14.0%	255.4	17.2	12/86	Palo Alto, Calif.
63	**Paradyne**	14.0%	261.1	-37.6	12/86	Largo, Fla.
64	**Applied Materials**	14.0%	149.3	1.2	10/86	Santa Clara, Calif.
65	**Teradyne**	13.9%	306.1	0.2	12/86	Boston, Mass.
66	**Applied Magnetics**	13.6%	128.1	4.1	9/86	Goleta, Calif.
67	**Advanced Micro Devices**	13.2%	576.1	-36.6	3/86	Sunnyvale, Calif.
68	**Siliconix**	13.1%	111.2	7.4	12/86	Santa Clara, Calif.
69	**Recognition Equipment**	13.0%	241.8	9.0	10/86	Irving, Texas
70	**Burr-Brown**	12.9%	112.8	3.7	12/86	Tucson, Ariz.
71	**California Microwave**	12.9%	104.4	4.4	6/86	Sunnyvale, Calif.
72	**Computervision**	12.8%	494.7	-5.8	12/86	Bedford, Mass.
73	**Tandy**	12.4%	3,036.0	200.6	6/86	Fort Worth, Texas
74	**Analogic**	12.3%	148.2	10.1	7/86	Peabody, Mass.
75	**Motorola**	12.0%	5,888.0	194.0	12/86	Schaumburg, Ill.
76	**IBM**	12.0%	51,250.0	4,789.0	12/86	Armonk, N.Y.
77	**Andrew**	11.6%	197.7	9.5	9/86	Orland Park, Ill.
78	**Data General**	11.5%	1,268.0	5.7	9/86	Westboro, Mass.
79	**Tracor**	11.2%	632.1	18.8	12/86	Austin, Texas
80	**MTS Systems**	11.1%	109.8	6.9	9/86	Minneapolis, Minn.
81	**Scientific-Atlanta**	11.1%	469.1	-9.2	6/86	Atlanta, Ga.
82	**Systems Industries**	10.4%	103.3	3.1	7/86	Milpitas, Calif.
83	**Cordis**	10.3%	188.1	-2.9	6/86	Miami, Fla.
84	**Unitrode**	10.1%	168.0	9.2	1/86	Lexington, Mass.
85	**Measurex**	10.0%	192.7	21.1	11/86	Cupertino, Calif.
86	**Intel**	9.9%	1,265.0	-183.3	12/86	Santa Clara, Calif.
87	**AVX**	9.8%	195.4	-3.1	12/86	Great Neck, N.Y.
88	**AMP**	9.4%	1,933.0	164.0	12/86	Harrisburg, Pa.
89	**Harris**	9.3%	2,216.6	59.6	6/86	Melbourne, Fla.
90	**Dataproducts**	9.2%	353.8	-26.8	3/86	Woodland Hills, Calif.
91	**Spectra-Physics**	9.1%	210.1	0.8	9/86	San Jose, Calif.
92	**Veeco Instruments**	8.6%	167.8	0.4	9/86	Melville, N.Y.
93	**Sun Electric**	8.6%	177.0	1.9	10/86	Crystal Lake, Ill.
94	**Arrow Electronics**	8.5%	529.6	-28.3	12/86	New York, N.Y.
95	**Fluke Manufacturing**	8.4%	209.0	12.2	9/86	Everett, Wash.
96	**Augat**	8.4%	260.4	-8.7	12/86	Mansfield, Mass.
97	**N.A. Philips**	8.4%	4,531.6	81.2	12/86	New York, N.Y.
98	**Xerox**	8.2%	12,900.0	488.0	12/86	Stamford, Conn.
99	**Zenith Electronics**	8.2%	1,892.1	-10.0	12/86	Glenview, Ill.
100	**Cubic**	8.2%	337.8	1.1	9/86	San Diego, Calif.

Source: ELECTRONIC BUSINESS

(Continued)

Fastest growing companies in 1986 by industry segment

Five-year compounded annual rate

Capital equipment	Sales growth	Profit change	Rank
Nicolet Instruments	15.9%	-10.5%	55
Gerber Scientific	15.5%	+15.4%	56
Hewlett-Packard	15.0%	+11.1%	59
Applied Materials	14.0%	-8.3%	64
Teradyne	13.9%	-44.5%	65
Tracor	11.2%	-0.2%	79
Spectra-Physics	9.1%	-19.6%	91
Veeco Instruments	8.6%	-48.2%	92
Fluke Manufacturing	8.4%	+7.5%	95
Weighted average	**14.2%**	**+9.3%**	

Communications	Sales growth	Profit change	Rank
Digital Communications	69.8%	+207.4%	7
DSC Communications	53.5%	NM	11
Cincinnati Microwave	42.4%	+28.8%	21
Micom Systems	39.1%	+24.6%	23
Timeplex	34.5%	+37.7%	26
Bolt Beranek and Newman	26.5%	+64.5%	31
General DataComm	25.3%	+16.3%	34
Dynatech	25.1%	+30.8%	36
Avantek	20.5%	+11.1%	42
Adams-Russell Electronics	15.2%	+6.0%	58
Paradyne	14.0%	NM	63
California Microwave	12.9%	+11.9%	71
Motorola	12.0%	+2.1%	75
Andrew	11.6%	-0.7%	77
Scientific-Atlanta	11.1%	NM	81
Weighted average	**14.7%**	**+2.3%**	

Components	Sales growth	Profit change	Rank
VLSI Technology	189.1%	NM	2
Western Digital	63.5%	NM	8
Monolithic Memories	21.8%	+5.0%	40
Analog Devices	16.4%	+38.5%	52
Molex	15.3%	+14.9%	57
Advanced Micro Devices	13.2%	NM	67
Siliconix	13.1%	+125.2%	68
Burr-Brown	12.9%	+15.4%	70
Unitrode	10.1%	-2.5%	84
Intel	9.9%	NM	86
AVX	9.8%	NM	87
AMP	9.4%	+4.0%	88
Augat	8.4%	NM	96
Weighted average	**12.4%**	**-28.7%**	

Computers	Sales growth	Profit change	Rank
Apollo Computer	158.4%	NM	3
Convergent Technologies	87.8%	NM	5
SCI Systems	51.3%	+34.8%	12
Altos Computer Systems	44.4%	+53.5%	18
Cray Research	42.5%	+47.0%	20
Apple Computer	41.5%	+31.3%	22
Telex	30.6%	+52.9%	29
Tandem Computers	29.8%	+19.2%	30
DEC	18.9%	+12.5%	45
Prime Computer	18.7%	+4.5%	46
Amdahl	16.9%	+9.3%	50
Hewlett-Packard	15.0%	+11.1%	59
Tandy	12.4%	+3.4%	73
Analogic	12.3%	+2.8%	74
IBM	12.0%	+7.7%	76
Data General	11.5%	-32.4%	78
Weighted average	**14.1%**	**+8.9%**	

Computer-based systems	Sales growth	Profit change	Rank
Intergraph	46.1%	+53.5%	16
ISC Systems	38.7%	+25.5%	24
Computer Products	26.0%	NM	33
Evans-Sutherland	18.7%	NM	47
Computer Consoles	16.6%	NM	51
Data Card	16.3%	+12.5%	54
Coherent	14.7%	+1.3%	60
Recognition Equipment	13.0%	NM	69
Computervision	12.8%	NM	72
MTS Systems	11.1%	+14.3%	80
Measurex	10.0%	+58.6%	85
Sun Electric	8.6%	NM	93
Weighted average	**18.8%**	**+12.4%**	

Defense electronics	Sales growth	Profit change	Rank
Electrospace Systems	26.1%	+36.7%	32
Loral	22.8%	+18.7%	39
Logicon	21.2%	+27.5%	41
AEL Industries	17.0%	+33.6%	49
E-Systems	14.7%	+20.9%	61
Watkins-Johnson	14.0%	+20.9%	62
Motorola	12.0%	+2.1%	75
Harris	9.3%	-10.8%	89
Cubic	8.2%	-36.7%	100
Weighted average	**12.4%**	**+3.4%**	

Distributors	Sales growth	Profit change	Rank
Emerson Radio	45.2%	+119.9%	17
Anthem Electronics	23.6%	+7.4%	37
Marshall Industries	18.3%	NM	48
Pioneer-Standard	16.4%	NM	53
Arrow Electronics	8.5%	NM	94
Weighted average	**19.5%**	**NM**	

Office equipment	Sales growth	Profit change	Rank
NBI	37.4%	NM	25
Wang Laboratories	25.3%	-8.2%	35
IBM	12.0%	+7.7%	76
Harris	9.3%	-10.8%	89
Xerox	8.2%	-4.0%	98
Weighted average	**11.6%**	**+5.6%**	

Peripherals	Sales growth	Profit change	Rank
MiniScribe	369.5%	NM	1
Seagate Technology	115.9%	+82.9%	4
Priam	84.7%	NM	6
Emulex	59.9%	+42.9%	9
Micropolis	54.9%	+136.4%	10
Xebec	51.0%	NM	13
Cipher Data Products	48.2%	+144.7%	14
Intelligent Systems	46.2%	-53.9%	15
Xidex	42.6%	+36.6%	19
Tandon	31.6%	NM	27
Decision Industries	31.2%	+41.8%	28
Printronix	20.3%	NM	43
Key Tronic	20.3%	-31.6%	44
Applied Magnetics	13.6%	-23.9%	66
Systems Industries	10.4%	-7.5%	82
Dataproducts	9.2%	NM	90
Weighted average	**33.8%**	**-11.0%**	

NM = Not meaningful

Source: ELECTRONIC BUSINESS

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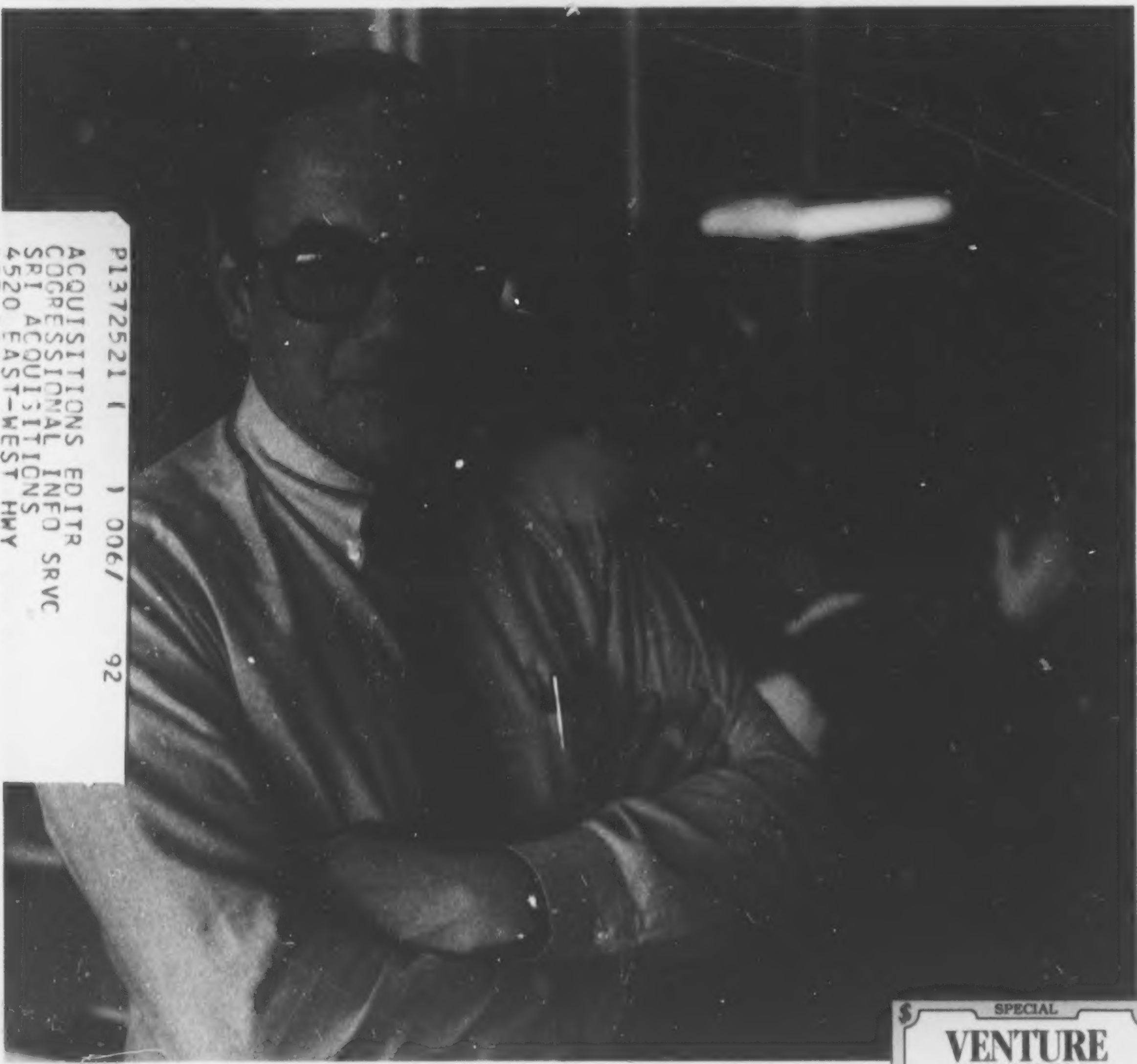
A CAHNERS PUBLICATION

MAY 15, 1987

Electronic Business

Disk drives: Satisfying a high-performance marketplace

CMOS: A $5.5 billion business for complementary chips



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Lew Platt: Fine-tuning HP's manufacturing strategy

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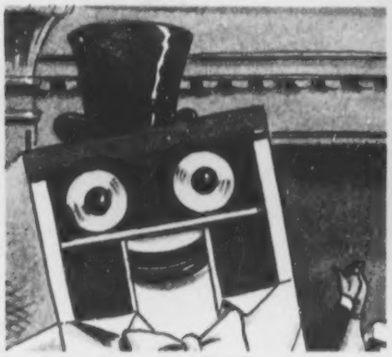

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If you've got it, flaunt it. That's how Beckman plans to gain share in the resistant resistor market.

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As the technology has moved into more and more segments, CMOS chips have become a $5.5 billion business.

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Physical limitations and fabrication problems are key issues to watch as CMOS ICs approach new geometries.

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The outlook for U.S. computer production brightens

The trade deficit in computers and office equipment widened last year, but Cahners projects growth

If the squeaky wheel gets the grease, then the U.S. computer and office equipment industry should learn to squeak louder. While much attention has recently focused on the U.S. semiconductor industry's screams for help, the U.S. computer and office equipment industry has long been suffering in silence.

Last year the U.S. trade deficit in computers and office equipment totaled a whopping $4.6 billion, sharply up from $1.1 billion the year before, according to Analytics, a market research firm located in Palo Alto, Calif. For the first half of this year, Analytics is predicting a $2.3 billion deficit.

Nevertheless, Cahners Economics — our in-house forecasting unit — remains optimistic about 1987, predicting a 6.4% rise in the U.S. production of computers and office equipment (SIC 357). Regarding quarterly growth, Cahners says U.S. production will grow by about 2.5% this quarter, 3.5% during the next quarter and 4.5% during the fourth quarter of this year. By the end of this quarter, in fact, Cahners estimates that the industry be well on its way to surpassing the previous peak in SIC 357 production from two years ago. For 1988, Cahners says U.S. production will increase by 13%.

"Computer manufacturers received an estimated $1.87 billion in new orders in January," Cahners reports. That was down sharply compared with December when a year-end flurry of buying activity, due in part to the new tax law, pushed orders to $5.78 billion. Shipments also got off to a slow start this year, in line with the normal seasonal pattern, our economists also note. January's total was $2.55 billion, down from $6.28 billion in the prior month. "New product cycles," our forecasters add, "continued improvement in exports, and a pickup in U.S. business investment is still expected to carry the market upward in 1987."

Nevertheless, the trade deficit still worries Analytics. The deficit in the industry is most acute with data-processing equipment where the deficit was $3.3 billion last year. In addition, the United States also imported last year more than $1 billion worth of photocopiers than it exported. All told, imports currently account for around 13% of the U.S. market for computers and office equipment, estimates Analytics.

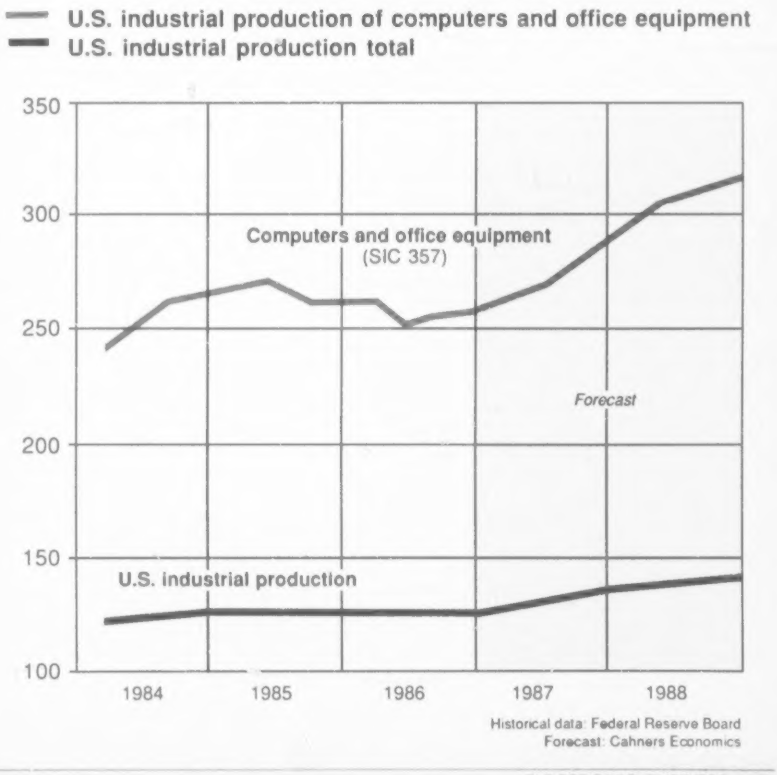
Many market analysts foresee a further widening of the trade gap, due in part to an increase in offshore manufacturing which has been recently fueled by the U.S.-Japan semiconductor trade agreement. One result of the agreement has been higher chip prices in the United States which provide yet another reason for U.S. systems manufacturers to relocate manufacturing operations offshore.

Looking further ahead, Analytics is predicting that the U.S. production of computers and office equipment will increase by only 1.9% this year, a substantial change from last year when production fell by nearly 15%. It agrees with Cahners, however, for 1988, predicting a 13% increase over this year.

ALDEN M. HAYASHI

Computers and office equipment

Industrial production indexes, 1977 = 100



Historical data: Federal Reserve Board
Forecast: Cahners Economics

Electrical machinery

Manufacturers of electrical machinery (including electronic components and communication equipment) operated at 71.7% of capacity during the fourth quarter of 1986, up slightly from the third quarter's 71.4% rate. This increase corroborates other evidence that the industry has begun to emerge from the slump which began in mid-1984. Orders for most nondefense electronic products have accelerated in recent months, so plant operating rates are expected to show further near-term increases. Manufacturers should be operating at approximately 75% of capacity by the end of 1987 and at least 80% by late 1988.

Instruments

The rate of plant utilization in the instrument industry fell to 79.2% in the fourth quarter from an average of 80.3% in the previous three months. This was the ninth consecutive quarterly decrease and was a sign that production volumes continued to be restrained by weakness in U.S. capital spending. Although order rates are expected to start off slow in 1987, we expect capital investment levels to pick up somewhat after mid-1987, spurring increased production activity for instruments. The industry's operating rate will fluctuate near present levels through the summer but are expected to begin a sustained rise toward the end of the year, finishing 1987 at about an 80% rate. A further increase of three or four percentage points is expected to follow next year.

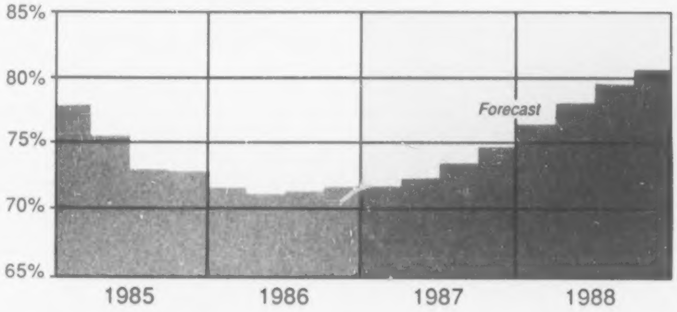
Aerospace

In the fourth quarter of 1986, the aerospace equipment industries utilized 89.2% of plant capacity. This was an extremely high rate by historical standards and represented an increase of nearly a full percentage point over the prior quarter. Recent reports suggest that utilization rates will remain in an 89% to 90% range in early 1987, but the recent squeeze in defense procurement authority should cause production activity to level off later in the year. These developments will pull the operating rate down slightly, to a fourth quarter average of approximately 86% to 87%. Look for more rapid declines in 1988, with the rate waning to nearly 80% by year-end.

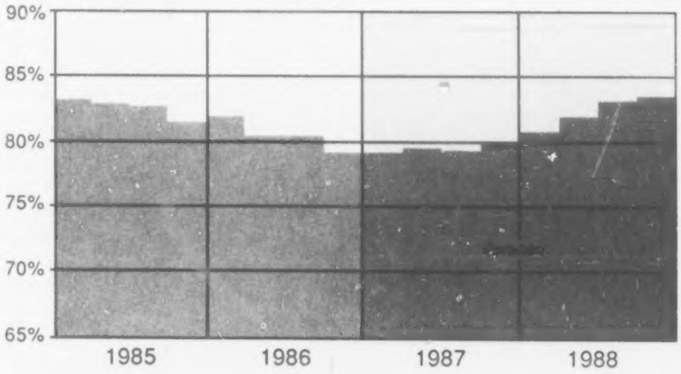
Plant utilization

Average percentage of capacity utilized per quarter

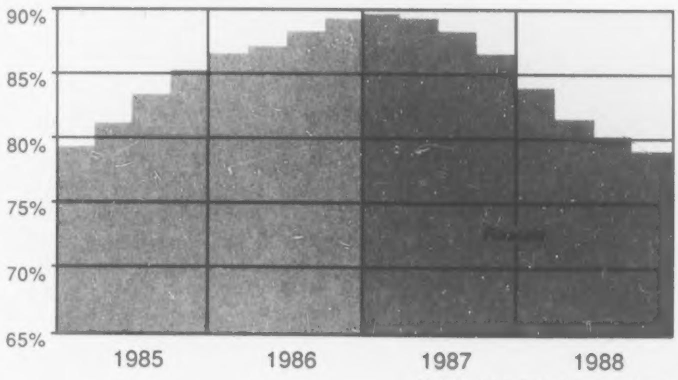
Electrical machinery (SIC 36)



Instruments (SIC 38)



Aerospace (SIC 37)



Historical data: Federal Reserve Board
Forecast: Cahners Economics

Electronic components and accessories

Many categories of electronic components, including capacitors, connectors and some types of semiconductors, experienced mild upward price pressures in late 1986. This pushed industry-wide prices up 0.3% in the fourth quarter, to a level which was more than 2.7% above the year-earlier period. This compared with an increase of just 1% for the entire first half of the year. Prices should continue to push upward over the course of 1987 as the unfolding business recovery gains momentum. Following a modest overall increase of 1.8% in 1986, prices are expected to climb approximately 3.2% this year and 4.4% next year.

Linear ICs

Fourth-quarter producer prices of linear ICs fell 3.5%, their sharpest downward move in nearly two years. On an annual basis, prices fell 5.1% compared to 1985. The declines came despite a fairly healthy improvement in the domestic market during 1986. According to the Semiconductor Industry Association, U.S. bookings for linear ICs increased 36% last year, and shipments achieved an 18% growth rate. As the market continues to pick up in 1987, supply conditions should begin to tighten and prices should start to climb. By year-end, prices are expected to be up nearly 10% from a year earlier and that steady climb will lead to an overall annual rise of 1.3%. An increase of 2.7% is expected in 1988.

Digital bipolar ICs

Producer prices for digital bipolar ICs, which had dipped slightly last summer, turned up again in the year's fourth quarter as demand from computer manufacturers and most other major end-user markets resumed an upward trend. Prices rose 1% in the final quarter and registered an overall increase of 4.1% for 1986 as a whole. Most industry analysts expect this market segment to show a moderate but sustained rise in 1987, and such an improvement in business conditions would be likely to trigger further increases in prices. They are currently expected to rise 9.6% in 1987 and about 8% next year.

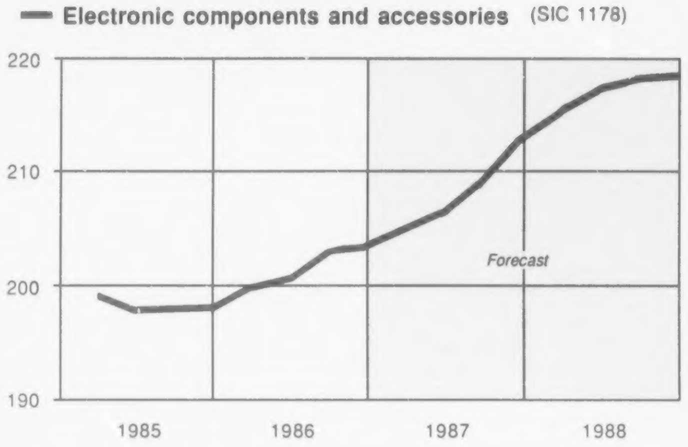
Digital MOS ICs

Prices of digital MOS ICs rose 3.1% in the fourth quarter of 1986, reversing the prior quarter's decline. Despite this uptick, prices were down sharply for the year, averaging 10.1% below the level in 1985. Reports for early 1987 suggest that prices continue to push upward, and we expect rising demand to help sustain this pattern well into the second half of the year. Annually, prices are forecast to increase 7.6%, their first rise since 1984 when the last business expansion was at its peak. Pricing will be more stable in 1988, showing an average decline of about 2.5%.

Producer price indexes

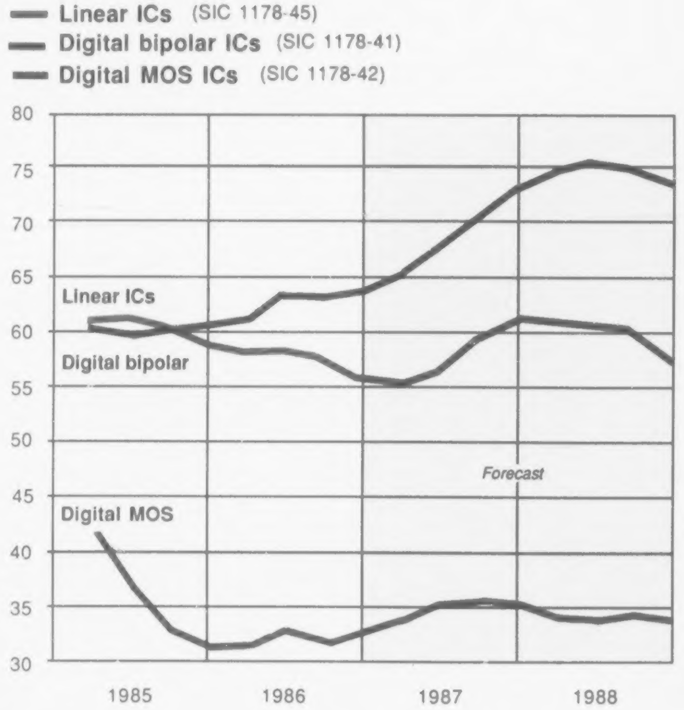
Electronic components

December 1967 = 100, quarterly averages



Integrated circuits

December 1974 = 100, quarterly averages



Historical data: Bureau of Labor Statistics
Forecast: Cahners Economics

Package selling reshapes computer maker marketing

Computer makers turn away from the hard sell hardware pitch to the softer solution sell

"In the late '70s, early '80s, deregulation hit and Hogan was in the right place at the right time," says Richard Aldridge, executive vice president for field operations at Hogan Systems. Deregulation, in this case, was in the banking industry and Hogan, a developer of financial software for IBM mainframes, was sitting pretty. Sales at the Dallas-based software house zoomed, doubling three years in a row.

Then things started to slip. Hogan had a tough time keeping pace with its own growth. The company's service and support, says Aldridge, became the worse for wear. Then Hogan made the mistake of shipping product before it was ready. In March 1984, the company released a new integrated loan package and mailed it off to 54 customers before testing the software. The results, says Hogan's vice president, were disastrous. "The package had gaping holes in it," explains Aldridge. "Our references fell apart, the competition had a field day and our sales dried up."

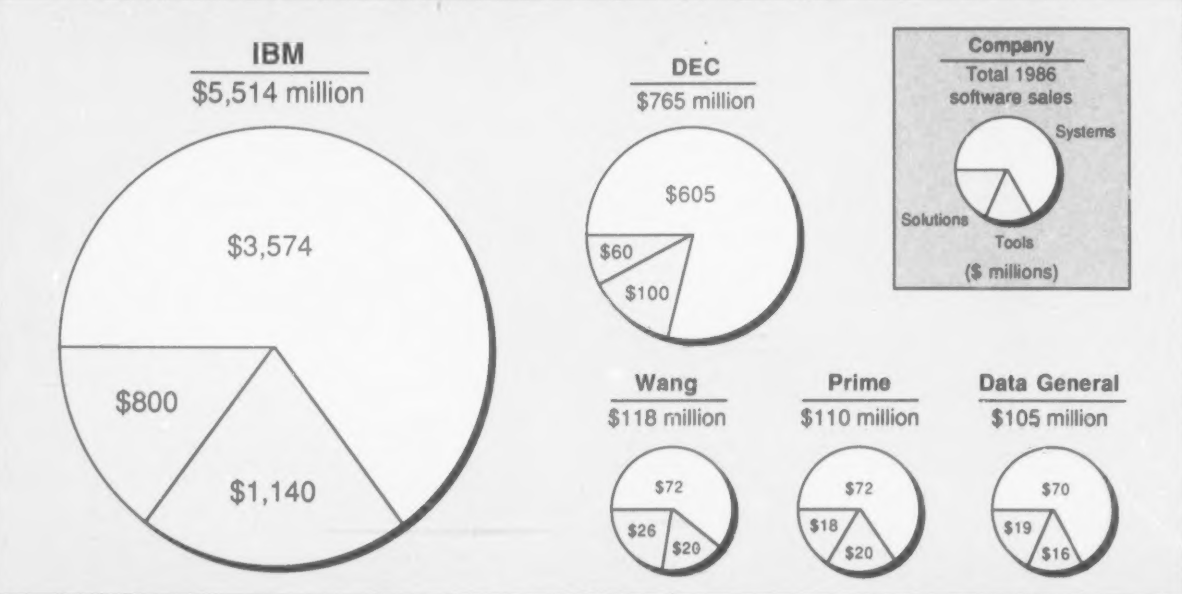
Then the company found itself in the right place again. IBM, aware of Hogan's presence in the financial world, approached the software company about a joint marketing deal. In May 1986, after 12 weeks of negotiations, IBM and Hogan signed five separate contracts that in sum gave the computer manufacturer exclusive rights to market Hogan software in the United States, Canada and Puerto Rico.

"I have read [in the press] that it was a one-way deal," says Aldridge. Many industry analysts portray it that way. The Hogan-IBM agreement, says Ted Jastremski, an analyst with Framingham, Mass., market research firm International Data Corp., "walks and talks like an acquisition." Says Mark Pines, also with IDC, "The Hogan deal amounts to IBM buying its way into a market."

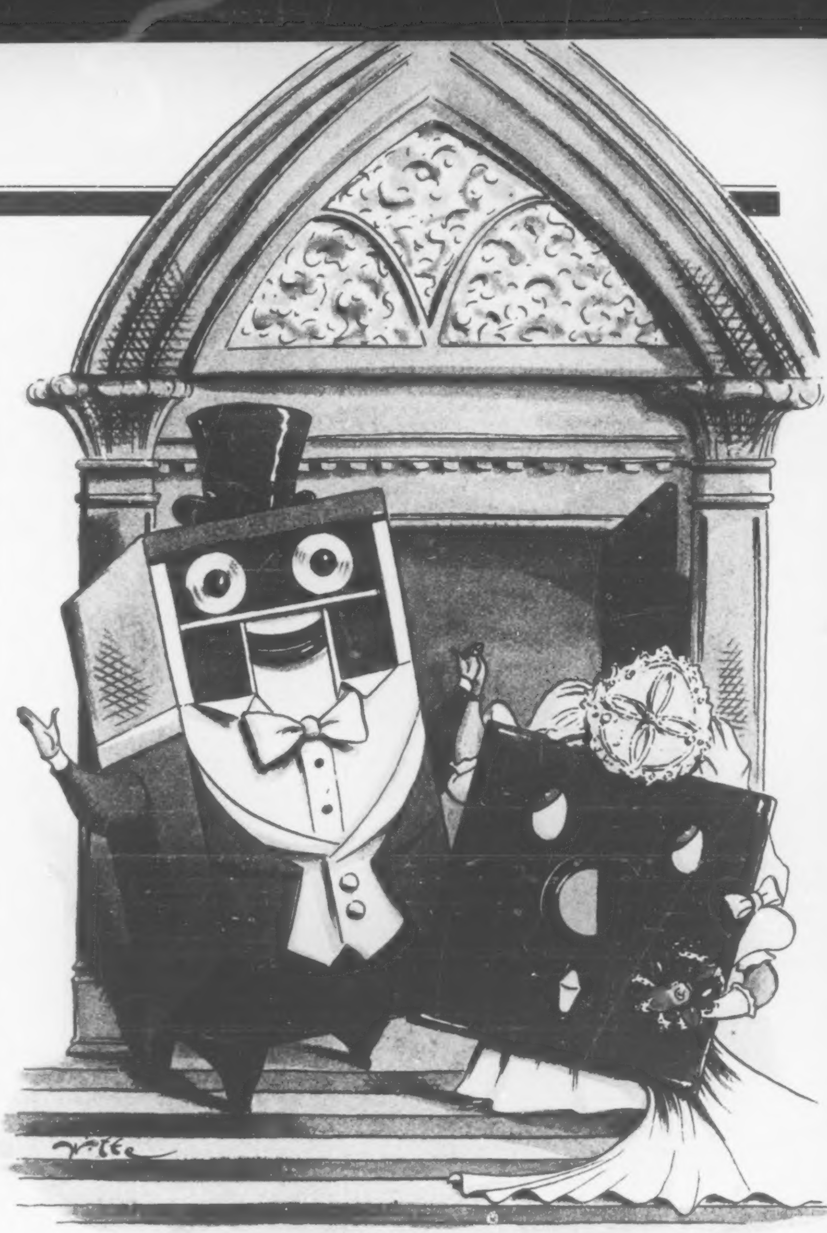
Hogan, though, is certainly benefiting from the agreement, too. The software company has virtually eliminated its sales and marketing costs in North America. Its customers, says Aldridge, are pleased that their software investment is now secured by IBM backing despite the fact that IBM has raised the price of the software approximately 20%. And Hogan is raking in between $800,000 and $1 million a month due to Big Blue's influence. Anyway, says Aldridge, "it was inevitable that Hogan would have to team up with someone."

Teaming up seems to be the catch phrase in the computer industry today. Another buzzword is "solutions." Almost every computer manu-

A sampling of hardware vendors' 1986 software sales



Source: International Data Corp.



Teaming up seems to be the catch phrase in the computer industry today

facturer is turning away from the hard sell hardware pitch of yesterday to the softer solution sell, which, as a complete package approach, includes both hardware and software. IBM and Unisys Corp., among other hardware makers, both have recently reorganized their sales organizations according to market, rather than geographic, boundaries. Salespeople at the computer makers now target specific vertical markets and talk complete solutions — such as an IBM 3090 mainframe running Hogan's Integrated Banking Applications — to the end user.

The evolution of IBM

"IBM wants to evolve into a full-service supplier," says Robert F. Borland, group director for strategy requirements and quality assurance for IBM's Information Services. But IBM, and the same can be said of any other computer manufacturer, cannot be all things to all people — at least not by itself. Realizing that, Digital Equipment Corp., Hewlett-Packard Co., IBM and many others are forging more partnerships with software companies.

Some match-ups involve exclusive contracts like the IBM-Hogan agreement. Other computer makers have made equity investments in, or made acquisitions of, software houses that target interesting markets. Wang Laboratories Inc., for example, has an equity stake in Custom Software Services, which writes software used in law, and acquired Walsh, Greenwood Information Services Inc., a financial package writer.

Probably the most prevalent type of arrangements are joint marketing agreements. Some involve sales calls made jointly by both hardware and software salespeople. Others require that the computer vendor supply the software company with sales leads. And many are informal referral arrangements; a hardware salesperson supplies a list of software packages written by third parties to prospective customers.

For most computer manufacturers, establishing partnerships with software companies has required some rethinking of corporate policy. "It is a major strategic shift for a hardware supplier that has grown up in the culture of doing everything itself," says James Turner, director of Unisys' worldwide cross-industry program. "You have to eliminate the NIH factor — 'not invented here.'" And it may require a change in focus. "A few years ago the emphasis [at IBM] was on hardware and systems software," says Borland. Today, he says, the emphasis is on application software and service.

But today, in-house development at most computer companies is still concentrated in systems software. According to Peter Burris, a software analyst with IDC, the software business is divided into three tiers. On the bottom of the pyramid is systems software, primarily the operating system. Next are utilities and tools such as language compilers and programming tools. These two blocks of the pyramid have naturally gone to hardware makers, especially those with proprietary operating systems, such as DEC's VMS and IBM's MVS.

Computer makers have been happy with the systems and tools business. Combined, the two are a $11.65 billion business. Both types of software have higher margins than hardware; IDC's Jastremski says that IBM, for example, reportedly makes 50% margins on its software. Systems and tools are generic software that can be sold to every customer regardless of application; and they represent guaranteed, recurring revenue because end users, for the most part, are locked into buying, servicing and updating them.

Application packages, on the other hand, are prone to competition, says Harvey Poppel, partner at New Jer-

Michael Witte

DEC's EARL COOK, manager of electrical CAE/CAD marketing, says engineering-oriented applications "are our family jewels"

Henry Hilliard/Picture Group

sey-based acquisition and merger specialist Broadview Associates. In addition, manufacturers have limited software resources and systems and tools have to be considered first. "It depends upon the market opportunity," says Michael Galane, R&D lab manager of Hewlett-Packard's Manufacturing Productivity division. "But there is always a higher priority on systems software."

Customers are also looking for more application packages, or complete solutions today, says John Doherty, manager of DEC's earth resources Cooperative Marketing Program (CMP). Even large oil companies, which have been writing their own software for years, want hardware vendors to provide turnkey systems.

Last, but not least, writing application software for any market demands expertise in that particular industry. But computer manufacturers have expertise in a relatively small portion of the overall market for computer systems.

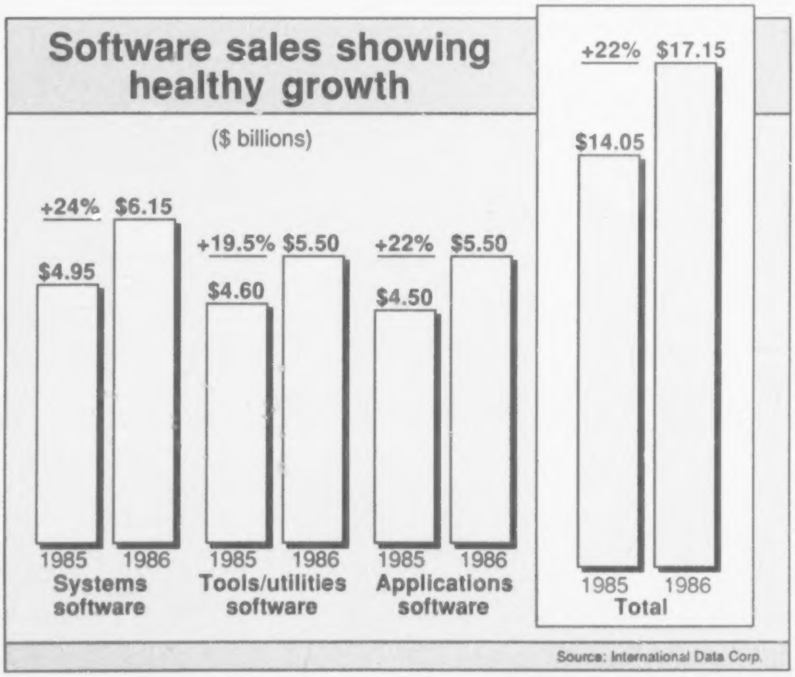
"To develop software for a particular market," says HP's Galane, "requires a lot of knowledge about the market and the user." If a hardware company wants to sell software developed in house for an application that it has little first-hand experience in, says Galane, one of three things has to occur. The company has to either "port the expertise" by contracting it out to consultants; "hire the expertise" by recruiting employees experienced in the application's industry; or "do a poor job."

The supposed change in emphasis on application packages brings independent software vendors (ISVs) into the picture out of necessity. IBM's philosophy, says Borland, is "to develop only that which we have expertise in." IBM sells some application software written in house. For example, the company offers MAPIX, its own general ledger and accounts receivable package for manufacturing. HP markets its own Manufacturing Resource Planning (MRP) software written in house — particularly for high-end systems and sophisticated users — and also sells manufacturing software developed by third parties. In the manufacturing market, HP also has a few original equipment manufacturer (OEM) deals, including one with ASK Computer Systems Inc., and joint marketing deals like the one with Computer Solutions Inc., a writer of MRP software for first-time users.

DEC, on the other hand, uses and sells MRP software from NCA Corp., exclusively marketing NCA's MAXIM MRPII software in the Far East. (DEC sells MRP packages developed by a number of ISVs The company's manufacturing planning and control systems group offers about 300 application packages, all of which have been written by third parties.) DEC markets few in-house developed application packages, but it does sell some proprietary computer-aided software engineering (CASE) packages. DEC would rather keep most packages to itself, especially engineering-oriented applications. "Those," says Earl Cook, DEC's manager of electrical CAE/CAD (computer-aided engineering and design) marketing, "are our family jewels."

Distinct third-party programs, however, designed to handle relationship with ISVs and value-added resellers (VARs), are relatively new departments at most major computer makers. "Until very recently, hardware

Software sales showing healthy growth



Source: International Data Corp.

companies regarded software as a necessary evil," says Broadview's Poppel. "It is only in the last two or three years that support programs [at hardware companies] have become extensive."

But today almost every major computer maker has formal third-party programs. DEC implemented its Systems Cooperative Marketing Program (SCMP) — for software companies that resell DEC hardware themselves — and its CMP — for companies that sell their software in conjunction with DEC hardware — about two years ago. The programs originated in DEC's mechanical division, says George Novoson, manager of mechanical applications at the minicomputer maker. The programs expanded, says Novoson, into all divisions at DEC and resulted in corporate-wide policies and guidelines for third-party relationships. The restructuring, says Novoson, "was a major change for the company."

Today, DEC's electrical CAE/CAD division has about 15 ISVs and "many more OEMs," according to Cook. Its mechanical CAD department has "close to 30 software partners and six resellers," says Novoson. And its earth resources division, says DEC's Doherty, is working with about nine ISVs.

Tandem Computers Inc. has grown its list of affiliated third-party software houses from 35 in 1983 to 250 through its Alliance program, started in late 1985. Wang Laboratories' Marketing Assistance Agreement program gives third-party software houses 4% to 12% of the net sale of Wang hardware if their package is sold with it. IBM's Vendor Logo Program, geared toward software for its Personal Computer, allows IBM to act as a distributor for a number of third-party application packages, says Borland.

The list goes on. Software makers, too, are establishing divisions for third-party agreements with hardware makers. They are equally eager to establish mutually rewarding agreements with hardware suppliers.

Cullinet Software Inc., for example, recently set up an original equipment manufacturer sales division, headed by James G. Blake, vice president of the company's distribution channels division. Within a month the division had signed deals with two OEMs — Cognos and Measurex. Says Blake: "Why should they [hardware companies] reinvent the wheel? With the market being the way it is, it's always best to stick to your own knitting."

Cullinet has also made its own software acquisitions. Last year the company bought Computer Strategies Inc., a writer of repetitive manufacturing software. In January, Cullinet purchased Planning Control International Inc., a government-reporting, project-management and financial-tracking software developer, for $4.3 million. And analysts are waiting to see how well Cullinet will fare against the IBM-Hogan duo when the company brings out new financial packages later this year developed by Bob White Systems Inc., another Cullinet acquisition.

Distinct third-party programs are relatively new departments at most computer makers

Cullinet is not the only software company getting in on the act. Management Science America Inc., for instance, bought Arista and Comserve, two MRP software companies. In addition, MSA bought Information Associates Inc., and RTS Ltd., an Irish writer of real-time software. MSA, which is known for its financial mainframe software, wants to expand its markets, in part because of the threat presented by the IBM-Hogan deal and also due to the opportunity presented by DEC's growing presence in manufacturing.

"We're beginning to move our focus into the minicomputer environment," says Keith Cooley, executive vice president at MSA. "We're not migrating mainframe packages down to minis. There is a need for distinct packages, especially in manufacturing." Adds Cooley: "The DEC area is obviously one we need to address."

Maintaining these partnerships — both formal and informal — is a balancing act for both hardware vendors and software suppliers. Ideally, computer makers would like as many applications running on their machines as possible. To accomplish that, hardware companies have to encourage many software developers to write

Fortune's pet tiger

For some computer makers, software represents more than an add-on to its hardware sales; it may be salvation.

Fortune Systems Corp., for example, decided to spin off its software division into a wholly owned subsidiary when the popularity of its word-processing package was growing faster than its hardware sales. That way, says Susan Espy, vice president and general manager of Tigera Corp., the newly formed software subsidiary, Fortune could capitalize on its software strengths by selling in high volume to some of Fortune's direct competitors.

Tigera, established in June 1986, now sells Word Era, its newly named word-processing package, through original equipment manufacturing agreements with Convergent Technologies, Plexus and Pyramid Technology Corp. This year alone, Tigera plans to spend 60% of its operating budget on the development of new software products.

Convergent, faced with the withdrawal of AT&T's and Burroughs' OEM business, says Harvey Poppel, partner at New Jersey-based Broadview Associates, has had to completely restructure its business. In the process, Convergent has made a number of software acquisitions including the purchase of Display Data Corp., a writer of software for the distribution and wholesale industry. "It is a whole repositioning of the company," says Poppel.

Other acquisitions that have occurred recently in the software industry, according to W.T. Grimm & Co., a merger and acquisitions firm in Chicago, are: Ashton Tate bought Decision Resources Inc., a maker of business graphics software, for $13 million; Harris Corp. purchased Scientific Calculations, a developer of computer-aided design software, for $30 million; Intergraph Corp. bought CNR Research Company Inc., a CAD software writer, for an undisclosed amount; Lotus Development Corp. acquired both Graphic Communications Inc. and Infocenter Software; Microsoft Corp. bought Dynamical Systems Research Inc. for an undisclosed amount; Silvar Lisco purchased NCA Corp. for $5 million; and Ungermann Bass Inc. acquired Linkware Corp., a writer of market information exchange software. ☐

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software for their systems. At the same time, computer makers do not want to alienate any potential allies.

The Hogan-IBM deal is a case in point. Many analysts conclude that IBM did not buy Hogan because of antitrust concerns. IBM's Borland says legal complications had nothing to do with it. Broadview's Poppel agrees. He says that despite the fact that the deal is a "de facto acquisition," IBM did not buy Hogan because it did not want to risk offending other financial software companies.

For IBM, that may be beside the point. Companies that write software for mainframes have to write for IBM machines; IBM owns about 75% of the mainframe market, and at least another 3% to 5% goes to plug-compatible makers. DEC also has such a presence in certain markets that few software companies cannot compete in those markets unless they write applications for VMS. In fact, says IDC's Jastremski, many software companies are jumping on the DEC bandwagon because they are afraid IBM is going to shut them out. "Software vendors are looking at the DEC platform as a haven," he says.

Hardware competition

Meanwhile, many hardware companies want to sell some of their own applications, too. "We make it clear to third parties that we have proprietary software that competes with them," says HP's Galane. "Our obligation is to tell them where we are positioning our product." Says Galane: "The challenge is to position all those products so customers don't get confused and third parties don't get in our way."

Some analysts think that if anyone gets in anyone's way it will be hardware companies knocking down software companies. "Hardware vendors are definitely going to make their presence known," in the applications market, says IDC's Jastremski. Considering that applications software is a $4.5 billion business, growing 22% annually, computer makers may not be able to refuse the business.

"As software becomes more of a margin business, hardware companies are looking to make more money off it," says MSA's Cooley. "There is certainly a possibility that hardware companies will bring software development in house more and more." But Cooley is not too worried. "I don't think any of them, including IBM, think they can write all the applications."

ANNE KNOWLES

The 5.25-inch format for high-end disk drives

The workstation market continues to thrive, and with it the market for high-capacity 5.25-inch disk drives

Like consumers everywhere, computer users are constantly demanding more for less, particularly in the area of storage. The 5.25-inch disk drive, the latest and smallest in a long line of high-capacity disk drive products, is the current target for much of this demand. Meanwhile, once standard 8-inch drives are slowly being edged out in favor of smaller form factors.

According to John Hime, Sun Microsystems Inc.'s director of product marketing, "we could sell our customers a gigabyte of memory today if it was available in a 5.25-inch format. Our customers can use all the disk space we are giving them and then ask for more."

Responding to this need are a bevy of vendors introducing high-capacity products in a 5.25-inch form factor in sizes ranging from 190MB to 760MB. Although few doubt this is the ultimate direction the market is taking, this move by vendors to ramp up to very high capacity may be premature at best. Some analysts, in fact, wonder if disk drive technology is once again outpacing demand.

"We are not near the end of the road for medium capacity products," asserts San Jose, California-based Quantum Corp.'s marketing director Rolf Brauchler. By medium capacity, most analysts mean products in the 100MB to 300MB range.

Despite announced or shipped product from a number of companies — including Control Data Corp., Fujitsu Ltd., Maxtor Corp., Micropolis Corp., NEC Corp., Priam Corp. and Toshiba, the existing market for true high-capacity drives is still relatively small.

According to market research firm Disk/Trend Inc. of Mountain View, Calif., the market for 300MB to 500MB 5.25-inch disk drives reached $75 million in 1986 and could reach $460 million by 1989, compared with the market for medium capacity drives — those between 100MB and 300MB — which was $276 million in 1986, and could be worth more than $1.3 billion in 1989. The market for drives with more than 500MB of capacity is negligible, Disk/Trend adds, with that market accounting for less than $21 million in revenue by 1989.

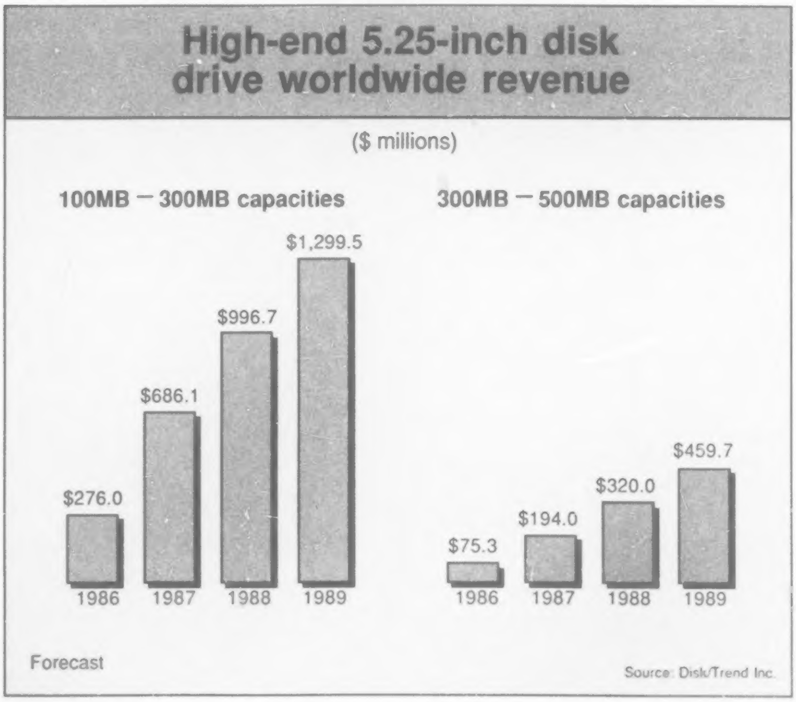
San Jose-based Maxtor already has taken an early lead in the high capacity 5.25-inch disk drive market. To date, the firm has shipped 10,000 units of its 380MB drive, and it claims it was the first to announce a 760MB drive, which will be available at the end of the year.

Competitors, however, are quick to point out that the battle is not yet over. Priam's director of product marketing John Hagerman, for example, says that key potential customers are only "just evaluating the products, and have not selected vendors at the over-300MB level. The votes are not in," he says.

International Data Corp.'s senior industry analyst David Vellante explains why. "Maxtor has to continue to outpace the rest of the industry," Vellante says. About "80% of Maxtor's business is in the under-200MB range, but 90% of Maxtor's talk is about the over-200MB range." This is premature, Vellante believes, because the only thing that a disk drive vendor must do to stay in the race is announce a 380MB product this year, even if it ships it next year. The biggest chunk of the market over the next 12 months to 18 months will be in the midcapacity 190MB range, he says, so companies like Priam, Micropolis and Quantum are far from out of the running. In fact, Micropolis in particular, which has a strong position in the popular 190MB product range should have a strong sales year in 1987, Vellante says.

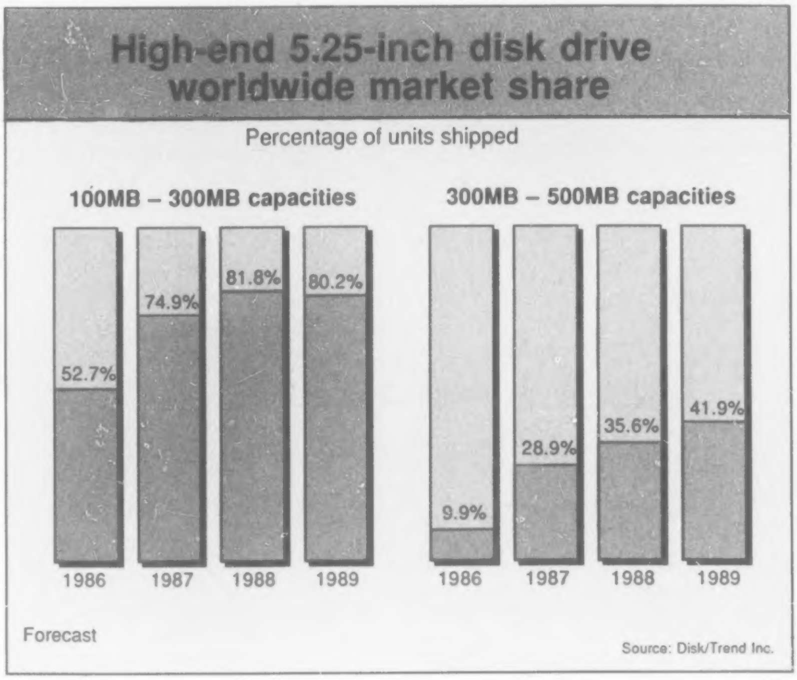
Other forces are at work as well. Although it would be easy to overlook the presence of 8-inch drives in the market today, most workstation vendors are continuing to use 8-inch and even larger products to fulfill users' memory needs. The reasons are fairly simple. David James, Hewlett-Packard Co.'s product manager for high-end disk drive products in Boise, Idaho, says that his company has to consider both cost and environment when installing a system.

In the past, the very high-capacity 5.25-inch drives that have been available have not matched the performance of the larger drives, James says. In that context, although size is important in the workstation market,


High-end 5.25-inch disk drive worldwide revenue

($ millions)

Source: Disk/Trend Inc.



High-end 5.25-inch disk drive worldwide market share

Percentage of units shipped

Source: Disk/Trend Inc.

performance is more important, and HP has yet to integrate any very high capacity drives in the 5.25-inch form factor. "The new drives from Micropolis and Maxtor are just coming out, and it does take HP a long time to integrate a drive in a system."

The nature of Sun Microsystems' business often makes the choice of an 8-inch drive possible, product marketing director Hime adds. "Workstations are pretty big anyway. These systems have big 19-inch monitors and take up a lot of desk space. I'm not sure we would trade capacity for a smaller form factor." That is one reason why Sun, a leading U.S. workstation vendor, has yet to introduce a 5.25-inch disk drive of more than 190MB. The company, Hime says, must take time to ensure reliability. "We are willing to trade off 10% to 20% in performance in order to get 10% to 20% better quality and reliability," Hime says.

On the other hand, the trend toward higher and higher capacity is inevitable. According to Disk/Trend's vice president Robert Katzize, "the general trend in the market is up," he says. "Partly that is because software is bigger and more people are using machines at once, and partly because the machines are used for more and more applications. All of this puts pressure on the drive."

Responding to that pressure, a number of vendors are planning products to take advantage of the growth. Micropolis, Chatsworth, Calif., is currently shipping evaluation units of its 380 MB drive and has plans to ship 760 MB drives by the end of the year. Priam has announced a 380MB 5.25-inch drive that will begin shipping in quantity at the end of the summer. Quantum has not officially announced anything but hints obliquely at the possibility of a "multiple hundreds of megabytes" product due out sometime at the end of 1987 or early 1988.

Other concerns

Disk drive vendors also have to contend with a number of concerns, including format standards. The systems industry as a whole is currently in a downsizing mode. Everything from the box on the user's desk to the cost of the product has to be smaller today. And although current market technology in the 5.25-inch market is predominantly full-height, vendors are likely to turn either to half-height 5.25-inch drives or 3.5-inch drives, both of which significantly reduce the space and power requirements needed in a system box.

"Anything you can do with a half-height 5.25-inch drive you can do with a 3.5-inch drive," IDC's Vellante says. "The issues are reliability and performance and the willingness of systems vendors to go to unknown technology." Quantum currently has a half-height 5.25-inch offering in the 170MB range, and Vellante indicates that Micropolis is planning to do the same in the near future. Priam is expected to release a 3.5-inch drive sometime this year as well.

Digital Equipment Corp., Hewlett-Packard and IBM now reportedly all have plans to develop their own high-capacity disk drives

Maxtor, which will soon announce a 3.5-inch 170-MB drive, will have all the bases covered whichever way the market goes, according to Robert Teal, marketing and sales vice president. "Ultimately it comes down to which form factor will be accepted," he says. "We can always package our 3.5-inch drives as 5.25-inch half-height drives if the market never develops for 3.5-inch. If it does, then we're there."

Another area of concern is interface standards. Currently there are three "standard" interfaces including a Seagate/IBM-compatible interface, as well as the Enhanced Small Disk Interface (ESDI) and the Small Computer System Interface (SCSI). Maxtor offers all three, but other companies, such as Quantum, are betting on the SCSI interface. As Brauchler of Quantum puts it, "there are not many really good midlevel capacity disks for just the SCSI market." Priam offers all three versions as well.

Meanwhile, 5.25-inch suppliers also realize they soon may have to contend with original equipment manufacturers, as well. Several of the largest users of 5.25-inch disk drives — including Digital Equipment Corp., Hewlett-Packard and IBM — have announced or leaked plans to develop their own high-capacity disk drives — for purely internal or merchant use, or both. This has to be unsettling to some, but Maxtor's Teal remains philosophical. "The industry hasn't changed much, and there are always two or three major companies that decide they can be disk drive manufacturers," he says. "In every one-year product cycle you can expect to lose one of your three customers this way, and you can expect to lose another of your three customers to a competitor. If you're lucky, you keep the final customer."

VALERIE RICE

At Hewlett-Packard, the word is CIM

Under Lew Platt, HP is developing a piecemeal strategy for the computer-integrated manufacturing market

By Alberto Socolovsky

Amid the functional furniture and open offices of Hewlett-Packard Co. in Palo Alto, Calif., president and chief executive John A. Young and his company's top managers periodically play host at seminars for their counterparts from other companies.

The roster of guests — top executives from firms such as AT&T, Ford Motor Co., GM Hughes Electronics Corp., Motorola Inc. — reads like a *Who's Who* of progressive management from other world-class American companies. And because every one of these firms is engaged, in one way or another, with battling foreign competition, the talk turns, naturally, to manufacturing rather than technology.

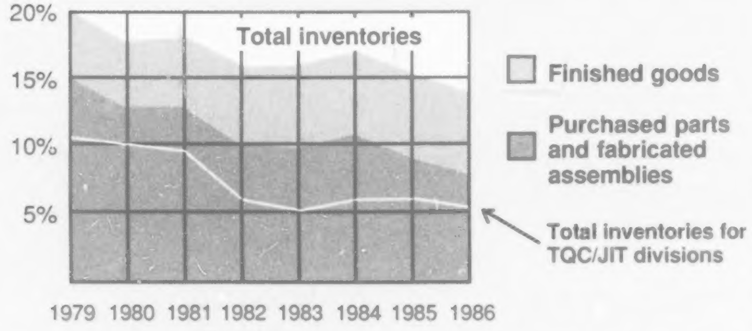
Although HP uses these seminars to promote its growing roster of computer-integrated manufacturing (CIM) products, chief executive Young first conceived the seminars — not as a vehicle to sell CIM — but to share his company's experience with other firms dealing with problems in manufacturing. Young, past chairman of the President's Commission on Industrial Competitiveness and now head of the Council on Competitiveness, believes that a competitive industrial America is good for HP. And he hopes that some of what worked for him will also work for others.

Even though many of the seminars emphasize the need for a coherent approach to implementing CIM, HP's own strategy for computer-integrated manufacturing grew out of more humble origins. Lewis E. Platt, senior vice president, says that CIM is being built piecemeal at individual divisions inside the company and involves the implementation of total quality control (TQC) to eliminate rejects and reduce rework during manufacturing. It also involves the development of just-in-time manufacturing to lower inventories. "CIM at HP consists of small steps. With TQC/JIT we got the biggest results," says Platt, a Wharton MBA, who heads a CIM task force at HP and oversees the company's own design and manufacturing, as well as the groups that make design and manufacturing systems for CIM. Through the application of TQC/JIT at several divisions, Platt says, HP has squeezed the inventory-to-sales ratio for the whole company from 20% in 1979 to 14% in 1986, and much lower for the divisions which have pioneered these applications.

Manufacturing performance alone, however, does not completely explain HP's interest in CIM. The $7 billion company also hopes to capture a major piece of the $48 billion worldwide CIM market and its $9 billion electronics segment. As head of HP's Technical Systems sector, Platt oversees the Engineering Systems Group, which makes workstations and design automation systems, and the Manufacturing Systems Group, maker of HP's automatic test equipment and computers for manufacturing. Both groups draw heavily upon HP's own design and manufacturing expertise — just as in the company's early days, when Hewlett-Packard was strictly an electronic instruments firm, designers would try their ideas and prototypes on the engineer working at the next bench. The approach eventually evolved into HP's legendary "next-bench" syndrome.

JIT and inventory management save dollars

Inventory as a percentage of revenue



Since 1979, HP has cut the cost of materials and work-in-progress inventory needed to make $1 of revenue from 15¢ to 8¢. Total inventories shrunk from 20¢ to 14¢ for the company, and from 11¢ to 6¢ for the divisions that pioneered TQC/JIT.

Source: Hewlett-Packard Company

LEW PLATT, senior vice president: "CIM at HP consists of small steps. With TQC/JIT we got the biggest results"

Reg Francklyn

"Look at the 'Joey' line," recommends CIM guru Thomas G. Gunn, director of Arthur Young's National Manufacturing Consulting Group. Joey, the code name for HP's low-cost ColorPro plotter, was the first application of JIT at the company's San Diego plant. The entire assembly line for this plotter — from the insertion of components on printed circuit boards (PCBs) to final test — fits into a fenced area of less than 10,000 square feet. Joey is a high volume — one million-plus plotters a year — yet flexible line, says Gunn, "through which go 30 different models, some of them in lot sizes of one. The line was designed for over 60 inventory turns in a year, direct labor is less than 1% of product cost."

"Joey is a factory within a factory. JIT, [and] the information systems and the materials handling [which support it] were designed specifically for that product," explains Brian B. Moore, former manager of the San Diego plant who now reports to Platt as general manager of the Manufacturing Systems Group. "It represents the [CIM] approach we recommend [at our executive seminars] — starting small, [and in] a logical progression. My group is starting to market this experience." In that sense, he agrees, HP's CIM development follows the "next-factory" syndrome. "We don't claim to have a $250 million CIM showcase like IBM's Lexington, Ky., [electronic typewriter] factory. Our customers feel a lot more comfortable when they go to San Diego and see results for less than $1 million."

Moore's group makes HP's highly regarded automatic circuit board testers and the popular HP1000 computers (widely used in manufacturing within the company, as well as by its customers, to control an area of workcells). These successful products serve as the beachhead for marketing the CIM experience, as well the group's latest computers: HP's powerful new "precision architecture" (previously code-named Spectrum) machines which are based on reduced instruction set computing.

JIT tours

But to market CIM Platt needs to do more than just show how HP's "think big but start small" approach works at its own factories. "CIM can't succeed without commitment from the top," he asserts. "You need the president [of your customer's company] to be committed to TQC/JIT."

Therefore, he values HP's executive seminars as a marketing tool for CIM; especially the informal discussions at the end of each session. And, he says, "I can think of lots of pieces of business that came out of those discussions."

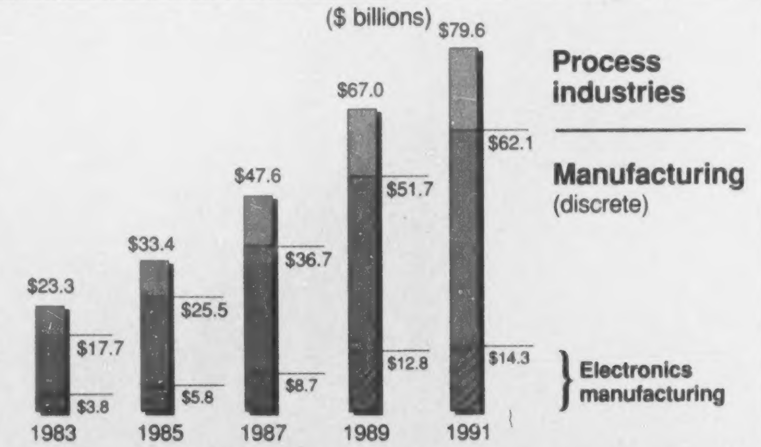
There is another plus to HP's executive seminars. "The CEO or VP of operations who attends sends a manufacturing VP or production manager for a one-and-a-half day seminar just on manufacturing, or an engineering manager for a design seminar. No charge," Platt says.

Indeed, many of the guests do follow up and send their manufacturing and materials managers to visit HP plants that have implemented TQC/JIT. They also attend the manufacturing seminars that several of these plants conduct. Visitors see gas chromatographs made in Avondale, Pa.; printers in Boise, Idaho, and Vancouver, Wash.; workstations and small Winchester disk drives in Fort Collins, and Greeley, Colo., respectively; instruments in Lake Stevens, Wash., and Rockaway, N.J.; and X-Y color plotters in San Diego. At each plant, the products and the manufacturing steps are different but the reports are similar. HP plant managers take pride in telling how, in the past three years, the piecemeal application of TQC and JIT has increased productivity, multiplied inventory turns, improved quality, reduced warranty costs, saved manufacturing space, and even reduced receivables.

BRIAN MOORE, general manager, Manufacturing Systems Group: "We don't claim to have a $250 million CIM showcase like IBM's Lexington, Ky., [electronic typewriter] factory"

JIT itself is implemented piecemeal. "Don't think of JIT as trucks coming into our dock. Before going to any outside vendors, we put JIT in place within our own factory," says Tom Viola, manufacturing engineering manager of the Fort Collins Systems Division, which builds the HP9000 32-bit workstations. "After we took 40 types of PC boards and merged them, we didn't have to build any boards for three months." Viola and his colleagues emphasize that they have not yet tackled CIM, but are continuously improving the process by adding, still in piecemeal fashion, more steps toward CIM implementation. Predictably, they plan to use more HP computers, particularly the new precision architecture machines.

Worldwide market for CIM



Of every five CIM dollars, four are spent for discrete manufacturing (as in autos), one for process industries (chemicals, food, petroleum). Today CIM for electronics represents 23% of discrete manufacturing.

Source: CIMdata

"I've been very pleased with HP's progress in JIT manufacturing," says Burnham Casterline, a Motorola vice president and director for manufacturing, who first introduced JIT in the manufacture of cellular mobile telephones, a leading Motorola product that faces fierce competition from Japan. Calling JIT "the entry point" for CIM, Casterline keeps tabs on HP's steps. A good customer — "we've had a fine relationship with HP for two years, buying instruments and test equipment," he says.

Casterline has also attended manufacturing seminars at several HP plants. So has John Lee, director for inventory management at McDonnell Douglas Computer Systems Co., the manufacturing arm of the large aerospace corporation's Information Systems Group. Lee does not claim to buy a lot from HP, "although the [company's] aerospace group does. I've three [Factron] Schlumberger board testers," and adds that he is unlikely to buy any more or any less, as a result of attending the seminars. But he attended them because, through a JIT consultant, who had previously worked at HP, "we were aware that the Fort Collins and Greeley plants were living models of what we're trying to do," says Lee.

Taking on IBM and DEC

To succeed in CIM, however, Hewlett-Packard must beat the same formidable rivals it has faced all along in the computer market: IBM and Digital Equipment Corp. IBM and DEC are the worldwide leaders in CIM (for all applications, including discrete and process manufacturing), with $3.5 billion and $2.3 billion in CIM sales, respectively, in 1986, according to Julius Dorfman, president of CIMdata. The Wellesley Hills, Mass., market researcher places HP as a distant third with $900 million, followed by General Electric Co., Intergraph Corp. and Computervision Corp. For electronics applications, the lineup of the top three is the same, says Dorfman, saying that electronics manufacturing accounts for almost 20% of the total market — but probably represents a larger share of the total CIM sales for DEC and HP than it does for Big Blue.

"The only three computer vendors

TOM VIOLA, manufacturing engineering manager, Fort Collins Systems Division: "Don't think of JIT as trucks coming into our dock. Before going to any outside vendors, we put JIT in place at our own factory"

worth talking about in CIM are IBM, DEC and HP," agrees Glen Allmendinger, president of Harbor Research. The management consultant from Cambridge, Mass., who specializes in CIM and industrial automation, says that IBM's lead harks back to its clout in management information systems; and DEC's place, to its large installed base of computers in manufacturing. "HP has computers in many businesses but can't point to any area where they lead," he says. But Allmendinger adds that HP has an opportunity to increase its share because recently it has been promoting CIM far more actively than its larger competitors. "They're bringing in highly refined tools, such as common user interfaces and applications generators."

Allmendinger is not alone, however, in his concerns about HP's ability to penetrate CIM accounts in areas outside of its traditional base of electronics manufacturers. Analyst Laura Conigliaro, for example, thinks the company will succeed in the electronics industry "where it has a loyal legion of users, and HP has provided good support." But, warns the senior vice president from Prudential-Bache Securities Inc., "I'd hate to see them take an industrial project in the rust bowl!"

In a way, the strategies by both IBM and DEC resemble HP's next-factory syndrome. Big Blue's catalog of software and hardware products for CIM states that "as a manufacturer, IBM is implementing its own CIM strategy to reduce costs, improve quality and enhance market responsiveness. As a vendor, IBM is committed to provide products and support in the CIM environment so that our customers can, likewise, realize these benefits and respond to business need." DEC also offers CIM solutions developed at its own factories, all of them based on its popular VAX computer and networking architecture, but recently it has expanded the VAX family to handle real-time applications and has entered into cooperative agreements with Honeywell Micro Switch and Rexnord Corp. in the CIM market.

Hewlett-Packard, however, is not waging this battle against IBM and DEC alone. It is also bringing in outside help. Recently, HP has been enlisting the help of third parties, or "value-added (V-A) channels," as the company prefers to call them. Actually, HP uses this term very broadly, because it already credits V-A channels for almost $1.9 billion worth of revenue in 1986 — one-third of its equipment sales. This is because one of the channels — original equipment manufacturers (OEMs) that build electronic systems incorporating HP computers and/or instruments — predates the CIM market by more than a decade. The OEM base consists of companies such as Gerber Scientific Inc., Measurex Corp. and Scitex Corporation Ltd., that have been building systems for CAD, the paper industry and cartographers, respectively.

On the other hand, HP credits systems integrators — which contribute both hardware and software — and software developers, for most of its CIM sales, which CIMdata estimates at $900 million in 1986. Both channels require a lot of support and close cooperation from the hardware vendor, something which only three years ago HP was not keen in providing. Moreover, HP has its own in-house systems integrator, the Advanced Manufacturing Systems Operation, which draws as much as possible on HP's products to implement custom solutions.

"We used to call [the third parties] a pain in the neck," admits Platt. "No longer. We went on to [call them] a necessary evil. Now they're an important part of our strategy." Platt's Technical Systems sector now even has a manager who works with value-added channels, and looks to them for help in penetrating nonelectronics applications. "HP knows a fair amount about electronics," asserts Moore. "But we don't know a whole lot about everybody else's process and their industries. We look on our value-added partners — all those people from which our customers can get help — as pretty important." A third, and increasingly important value-added channel consists of management consultancies such as Arthur Young, Coopers & Lybrand and Harbor Research. Although their value to HP centered in their influence in educating potential clients, AY and C&L have also set

HP's road map to TQC/JIT

Total Quality Control (TQC) process	Just In Time rids manufacturing of waste
• Commitment to continuous improvement • Gather failure data • Establish clear responsibility for action • Provide feedback of data • Drive the "PDCA circle" several times P: **P**lan to solve a problem D: **D**o analysis C: **C**heck effectiveness A: Take **A**ction, such as setting standards • Use statistical quality control as a tool	• Reduce inventories • Eliminate quality rejects • Reduce lot sizes • Reduce setup times • Reduce throughput times • Improve maintenance • Simplify the process • Total involvement (of people) at all levels

Source: Hewlett-Packard, Fort Collins Systems Division

ROBOTIZED ASSEMBLY STATIONS for odd-size ICs at HP's Fort Collins Systems Division

up CIM operations which function as systems integrators, says HP's value-added channels manager Steve Haslett.

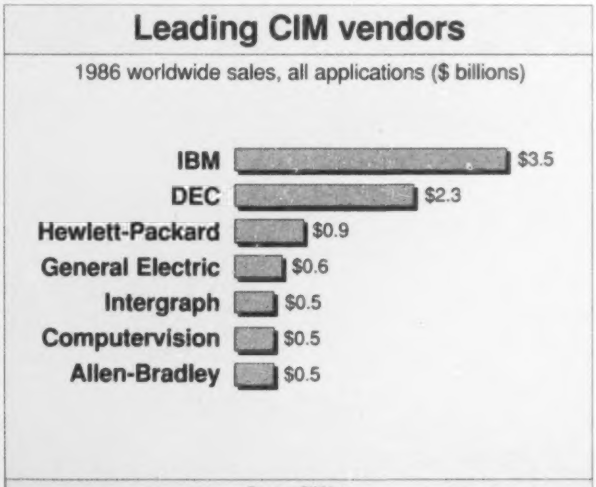
Adding value in electronics

The value-adders seem to be just as important to HP in electronics manufacturing. The main reason is that electronics customers buy computers from more than one vendor. "HP doesn't sell DEC computers," says Paul Paquette, a manager for the Dynamac division of CIM systems integrator American Cimflex Corp. "The reason they're in CIM is they want to sell computers, whereas we are in CIM because we want to solve customers' problems. At the [manufacturing] area-manager level, depending on the plant's standards, the computer could be HP, DEC, or IBM."

That kind of situation also exists at the Bramalea plant of Northern Telecom Canada Ltd., near Toronto, which makes line cards for the Digital Switching Division of the Canadian telecommunications giant. Richard Lue, manager for flexible manufacturing systems, says IBM PCs and HP150 microcomputers control individual workcells such as robots, automatic insertion machines and solder paste applicators. "The overall manufacturing process is driven by an HP1000," says Lue, "and we've worked closely with HP. But we have a couple of IBM hosts which store the design information and the business-operation data, such as order entry and work-in-process tracking." Denniston & Denniston Inc., a value-added partner of HP, is also developing the software to link the different levels and provide each cell with access to the data. "One station may have design data; another, inspection; a third one, wave-soldering information. We treat them as individual cells."

At Northern Telecom's U.S. operation in Raleigh, N.C., Hans Berger, director for advanced manufacturing automation, runs a line that makes similar line cards. But the line is three times larger than the Canadian line and uses HP's computers, including an HP3000 host for the management information system. "With our production volumes, we can justify more sophisticated levels of process control. [Going with HP computers] was the correct decision three years ago, I don't know what the decision would be today," says Berger. Writing the software was a joint project. "We wrote some, HP wrote some, the third party wrote some," says Berger.

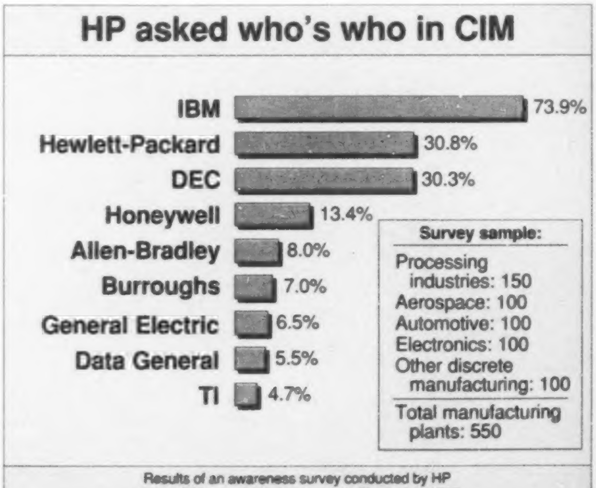
Dynacam, the systems integrator that developed special pallets and other materials-handling equipment that tie together the robotic and component insertion workcells at Northern Telecom's Raleigh plant, is already cooperating with HP on a potentially larger project for the Electrical and Electronics Division (EED) of Ford Motor Co. Dynacam's parent, American Cimflex, along with Hewlett-Packard, Industrial Networking Inc., and Motorola's Microcomputer Division, cooperated in a



Leading CIM vendors

1986 worldwide sales, all applications ($ billions)

Source: CIMdata



HP asked who's who in CIM

Results of an awareness survey conducted by HP among 550 manufacturing plants, in November 1985 pilot installation of the manufacturing automation protocol (MAP) at EED's plant in Rawsonville, Mich. "Teamwork is responsible for the steady progress we've made," says Robert M. Pearson, EED's manager for advanced manufacturing. In addition, the team is gearing up to participate in the automation of another of EED's electronics plants in Lansdale, Pa., thus helping HP in its goal to be a major supplier of CIM to the U.S. automotive industry.

Last September, HP Engineering Systems Group (ESG) also became part of Platt's Technical Sector. William G. Parzybok Jr., a company vice president, who is the group's general manager, says ESG's strategy rests on the HP9000, a general-purpose computing platform that is driven by industry standards such as the Unix operating system. As is the case with Moore's Manufacturing Systems Group, Parzybok's strategy includes value-adders, such as independent software vendors (ISVs) and OEMs, to penetrate unfamiliar markets.

For Motorola, an HP partner and supplier of the 68000-series microprocessors that ESG uses in the HP9000, the platform is solid. "Because [the 32-bit 9000-320 offers] Unix, it's an ideal vehicle to tie our different areas; first assembly, where your own 32-bit Delta computer controls the stations; then test, where we have several HP3065 board testers," says Richard T. Kelly, test engineering manager of Motorola's Microcomputer Division. In another 18 months to two years, says Kelly, his division will link design with assembly. "We'll download schematics and assembly drawings and display them in the production area." This, adds Kelly, combined with a 2-year-old JIT effort, will help his division meet Motorola's "6-sigma" project (less than 36 ppm) which aims essentially at zero defects, or total customer satisfaction.

Selling CIM

Although value-added channels can help HP in penetrating CIM accounts, the job of selling still rests largely on HP's highly regarded infantry — its salesforce. However, because CIM solutions cut across several product lines, HP had to reorganize its salesforce three years ago so that at the local level, according to Platt, "the [sales] organizations report to a single individual."

"Selling CIM is one of the most complicated processes at HP," says Richard K. Ellinger, sales manager of

AT A GLANCE

Hewlett-Packard Co.
Palo Alto, Calif.

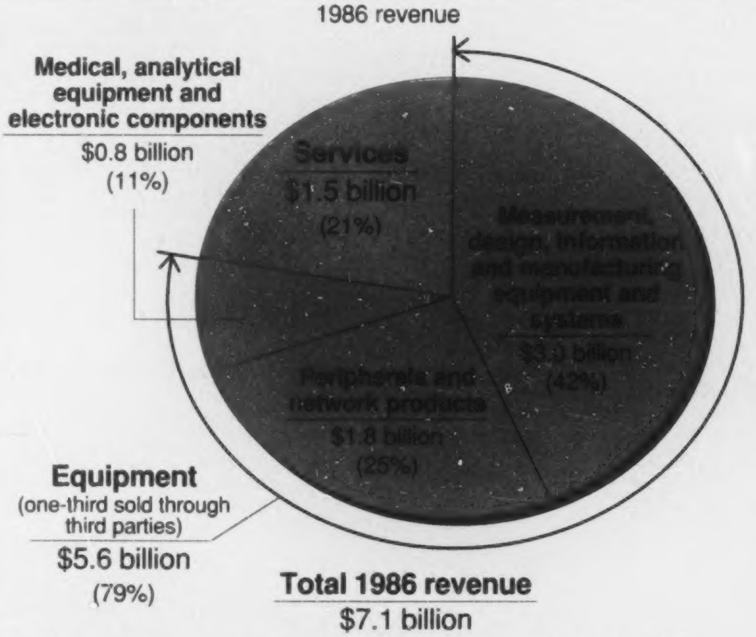
	FISCAL YEAR COMPARISON		
	1986	1985	Change
Sales ($ millions)	$7,102	$6,505	+9.2%
Net income ($ millions)	$516	$489	+5.5%
Net income/sales	7.3%	7.5%	–
Cost of sales/sales	47.2%	48.7%	–
R&D/sales	11.6%	10.5%	–
Marketing, G&A/sales	19.7%	18.2%	–
Capital expenditures/sales	7.0%	9.7%	–
Number of employees	82,000	84,000	-2.4%
Sales per employee	$86,610	$77,440	-11.8%
Net income per employee	$6,293	$5,821	+8.1%
Current ratio	2.51	2.43	+3.4%
Debt/equity ratio	0.0251	0.0256	-1.8%

Fiscal year ending October 31,

	MOST RECENT THREE MONTHS		
	1987	1986	Change
Sales ($ millions)	$1,740	$1,597	+9.0%
Net income ($ millions)	$116	$109	+6.4%

Three months ending January 31,

Third parties are first for HP in CIM



Third parties, or value-added channels, accounted for almost one-third (more than $2 billion) of HP's equipment sales. Value-adders involved in CIM must have accounted for most of HP's CIM sales, which CIMdata puts at $900 million for 1986.

Source: Hewlett-Packard

design and manufacturing systems. "You don't see many cases where [the demand for CIM] is driven by management, as in the case of GM. Usually, we deal with a manufacturer who has two-dimensional drafting, incoming inspection and manufacturing test, often from different vendors and installed at different times. In that case, we ask our salespeople to go in and make a mental road map of the process flow, or a transfer diagram of the machinery, and look for things that can be done better with MRP and JIT, which are flow-related." The salespeople must figure out the customer's highest priorities, even if the customer himself doesn't know them yet. In sum, an HP salesperson acts as consultant in manufacturing, communications networks, test, quality control and production variable analysis. "Sometimes, with key selected customers, John Young will invite their key executives to the executive seminar," adds Ellinger.

This brings the CIM sales job back to HP's top executives, underscoring what Platt and others at HP have been saying all along: implementing CIM is a big commitment, and it will never happen without a big commitment from the top. ☐

There's a software quality to John Young's memo

Much of what Hewlett-Packard Co. has to tell — and hopes to sell — about making quality hardware can be traced to a challenge John Young issued verbally to the company's managers at the beginning of this decade. Chief executive Young said that he wanted a tenfold reduction in failure rates of HP's hardware during the 1980s.

Today the company is well on its way to fulfill the boss' goal. But now Young is trying for an encore with software. And this time, he put the challenge in writing.

The hardware challenge stemmed from a study Young commissioned in the late 1970s to examine the impact on manufacturing costs of less than perfect quality. Company records showed that warranty costs were 2% of sales, but he was not satisfied with that answer. "He redefined the whole concept of cost of quality," recalls senior vice president Lewis E. Platt, "[to include all] rework and a lot of testing steps." Calculated that way, quality problems turned out to account for 25% of total costs.

"Well, that stirred John up," recalls Platt. "Most of us who were at the general management meeting [attended by HP's top 100 managers] in 1980 will remember the outcome. Addressing a bunch of people who had every reason to believe they were managing one of the highest quality companies in the world, he said: that wouldn't be enough. 'We're going to need an order of magnitude improvement in our failure rates during the decade of the 80s to remain competitive,' [Young said]." Platt admits that the first reaction was somewhat incredulous. "Was he serious? [Some people thought] he probably wanted to get a factor of two, but figured he'd have to ask for 10 ... to get two."

Young, however, was serious. "[His goal] was such a challenge," says Platt, "that you couldn't [meet it just by making] a few changes. Quality projects sprang up everywhere. People got serious about TQC." To quantify the goal, the managers devised a definition to measure failure rate: The number of failures in the first 105 days after shipment divided by shipment dollars. "It's very clear that we will achieve [10 times reduction by 1989]," reports Platt. "Some divisions are talking about factors of 12 and 15."

JOHN YOUNG, chief executive, encouraged by the response to his challenge to improve hardware quality, is now trying for an encore with software

Improvements in quality carry over to the bottom line, explains Platt, as inventories go down as a percentage of sales, manufacturing cycle times shrink, and even receivables from customers decline (from 62 days in 1979 to 53 in 1986). "People don't mind paying on time when they get the right product and it works," says Platt.

Kill the cute bugs

Encouraged by the response to his challenge on hardware, Young has extended it to software. "We need similar gains in the quality of our software products to achieve the same excellent reputation for quality that our hardware products have earned," he wrote in a memo to management in April of 1986. But this time he shortened the leadtime, and he, himself, defined how to measure the goal. "I want us to achieve a tenfold improvement in two key software quality measures in the next five years," wrote Young. "The first is aimed at our design process; the second at our ability to solve problems once customers have our products in place." The first measurement (post-release defect density) is the total number of known problem reports (KPRs) during the first year after initial shipment release, divided by the number of units shipped in that year. The second measurement (open critical and serious KPRs) is the number of unfixed KPRs classified as critical or serious by customers, reported monthly.

Although it is still too early to measure the improvement, Platt reports that the company's quality managers are starting by changing their vocabulary. "We don't call things that don't work in software 'bugs' anymore. Bugs [sounds like] a cute term. We call them 'software defects' today. Amazing what a change in words will do. Software defects [are] not as cute as a bug, they can be attacked just as systematically as hardware defects would be." ☐

Beckman Industrial shows some marketing muscle

If you've got it, flaunt it. That's how Beckman plans to gain market share in the resistant resistor market

By John Kerr

There was a time when Beckman Industrial Corp.'s Electronic Technologies Division (BI-ETD) apparently believed that competing meant never having to say you were there.

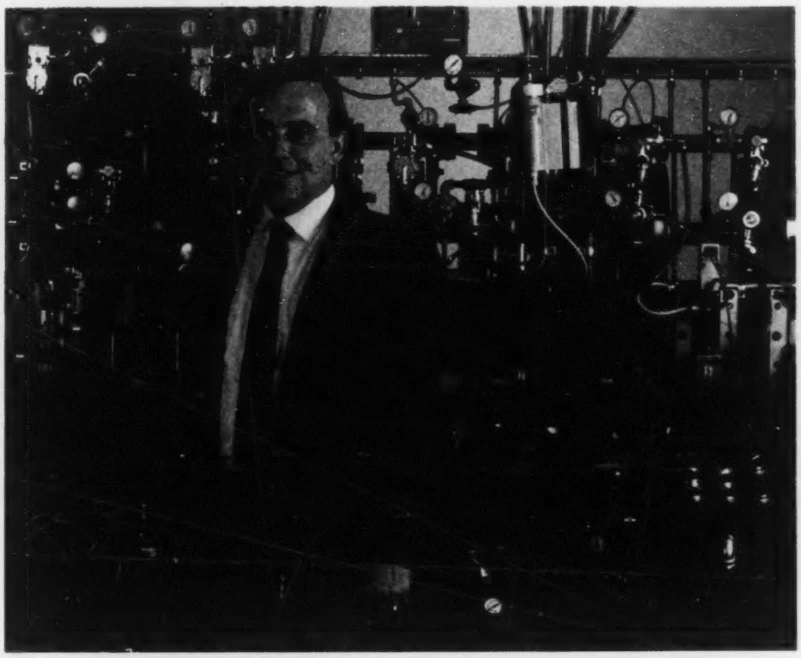
The Fullerton, California-based resistive-products maker would not advertise its wares. It shrank from publicity. This at a time when archrival Bourns Inc. was piling on the marketing pizzazz — and when resistor sales were congealing.

That promotional pallor prevailed long after Emerson Electric Co. bought BI-ETD from SmithKline Beckman Corp. in 1984. The unit drifted without a national sales manager for three months and without a distributor-sales chief for six months. "It looked like they were in the doldrums," says a competitor.

That is beginning to change. Under demanding new Emerson management, the division is getting a facelift. A number of new executives are now in place as Emerson veteran Dennis Moore, BI-ETD's president since February 1986, begins to make marketing more of a priority at the once publicity-shy outfit. "We need the visibility; in terms of industry awareness and customer awareness, you can't have too much," he maintains. At the same time, manufacturing facilities are getting a makeover: over $20 million has recently gone into new equipment and buildings.

The statistics suggest that Moore has a tough task ahead. In a market now experiencing excess production capacities, continual pricing pressure and only a meager uptick in demand, it will take exceptional efforts to do much for Beckman's undisclosed profits, which, although up last year, remain marginal.

Moore is undeterred. "We're doing less awfully than the others," Moore quips. His goals are annual revenue growth of 10% to 15% and operating margins that approach the Emerson ideal of 15%. But he admits that those profitability levels are out of reach for at least two years.



EMERSON VETERAN DENNIS MOORE has been recruited to insert some vitality into Beckman's industrial plan

Beckman traces its origin back to 1940, when founder Arnold Beckman invented the first multiturn precision potentiometer. Today about 35% of the division's $90 million-plus in sales comes from trimming potentiometers, also known as trimmers. The rest is portioned evenly among resistor networks; precision components, such as potentiometers and turns-counting dials; and hybrid microcircuits.

Beckman claims market leadership in precision pots and dials and the No. 2 slot behind Bourns in trimmers. Networks, where it ranks fourth, are the division's fastest growth sector and should rival trimmers as its major product area by 1990.

But, it is hard to become delirious about future prospects when the pundits say the market for your hottest product will be lucky if it experiences more than a 6% annual growth rate. Gnostic Concepts Inc., a San Mateo, Calif., market research firm, projects that U.S. original equipment manufacturer (OEM) consumption of networks, valued at $183 million for 1986, will inch up to only $238 million by 1990.

This is dynamite compared with the trimmer sector, which Gnostic estimates will drag from $148 million in 1986 to $154 million in 1990, and compared with the OEM resistive-products market as a whole, averaging only 2.4% annual growth to reach $1.091 million by 1990. Distributor sales are unlikely to do better. "There are no barn-burners right now," sighs

Robert Burroughs

Ray Allen, Beckman's resistive-products marketing manager.

Worse: despite shortages and lead-time stretch-outs in many resistor lines, customers still want to drive prices down. Although trimmer prices appear to be stabilizing, other sectors are still headed south: Gnostic forecasts a 7% annual slide in network prices.

Beckman has seen better times; the division enjoyed a bumper year in 1984. But not so in recent years as the computer slowdown began and other customers reassessed parts inventories. In fiscal 1985 (ended Sept. 30), BI-ETD was marginally profitable. For fiscal 1986, it barely broke even. Compared with overall performance at its Emerson parent, which netted $409 million on $4.95 billion in sales to make 1986 its 29th consecutive year of increased earnings, BI-ETD's results look shabby.

Moore on more

Luckily, Emerson is more interested in Beckman's future improvements than in past performance. Although they retain the luxury of autonomy, Beckman executives cite a key difference in the way their new parent manages: where SmithKline mandarins focused loosely on what had — or had not — been achieved, Emerson demands excruciatingly detailed plans outlining how performance will be bettered.

Moore has those plans in place. His recovery program touches most bases: manufacturing, quality, product and marketing. The overall aim is to improve customer responsiveness, which includes development of just-in-time manufacturing and ship-to-stock programs for major OEMs. "The customer is king — that's the message I keep giving people," says Moore.

FOUNDER ARNOLD BECKMAN invented the first multiturn precision potentiometer, or trimmer

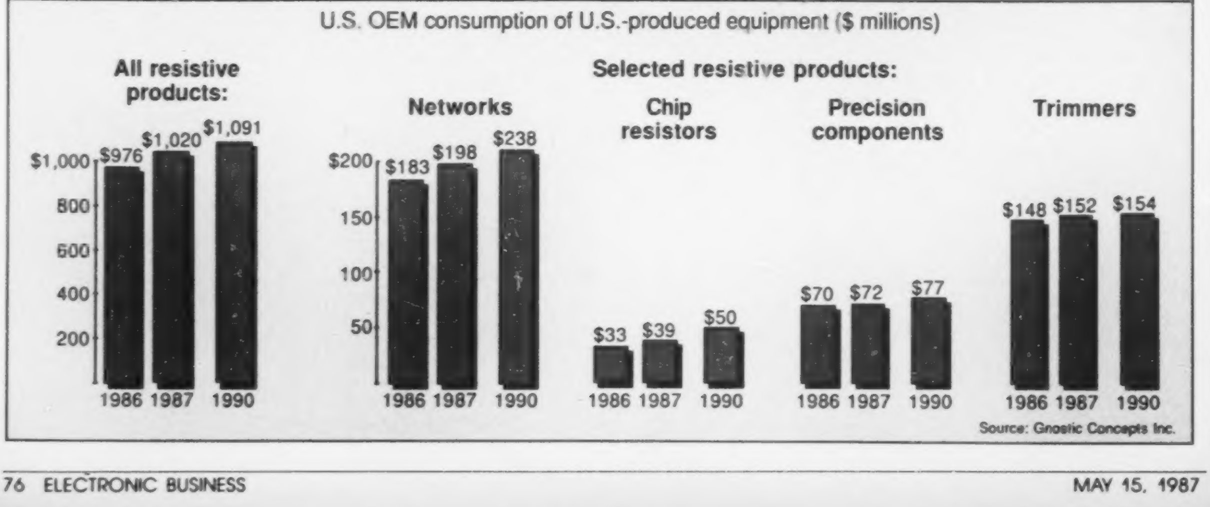
He is lucky to be able to build on a $20 million-plus investment in plant and equipment by Emerson. A new building houses high-volume production lines for microcircuits and networks. Other expenditures included: final assembly machines for trimmers and networks; automated wire bonders for microcircuits; and high-speed winding machines for precision components. The division is also promoting statistical process control to help cut trimmer production costs. And emphasis continues on what observers rate Beckman highly for: product quality. A new quality-assurance manager is on board, and two network lines already run below 100 defective parts per million (ppm). But there is no room for complacency: rival Bourns says that it means to hit 10 ppm by 1990.

The manufacturing push appears to be working. One distributor reports that some of Beckman's conformal-coated resistive products — polymer-coated components which are more economical and more flexible than molded resistors — easily beat Japanese imports on quality, price and performance.

Product offerings are also being broadened. The emphasis is on filling gaps in the trimmer lineup. A square quarter-inch multiturn unit makes its debut this month; other products are being redesigned for automation, or packaged in tape reels for users' machine insertion. In hybrid microcircuits, the race is on to get new products certified to the MIL-SPEC 1772 military specification that will soon become a standard.

Beckman is also responding — more cautiously than some of its competitors — to seminal demand for surface-mounted devices (SMDs), a market that so far has defied forecasters who said that 40% of resistive products sold by 1990 would be SMDs. "We're skeptical it'll be that high," says Moore. BI-ETD's new Model 632 Dense Pack network typifies the trend: it crams 36 resistors into a single 20-lead square molded package.

Product advances owe much to Beckman's top-notch analytical laboratory, claims Moore. He points out that progress in resistors relies less on electronics know-how than on innova-



Beckman's key product sectors still look sticky

U.S. OEM consumption of U.S.-produced equipment ($ millions)

Source: Gnostic Concepts Inc.

tive application of materials like conductive plastics.

On the marketing front, Moore has hired two ex-Bourns executives with cast-iron reputations. Together, national sales manager Robert Sickler and distributor sales manager Edward Palwick are putting some magic back into marketing. "Bourns has done a very good job. We're really running to catch up," concedes Sickler.

He has introduced a "Focus Account Program" that ensures slavish attention to the needs of the dozen customers that provide the bulk of Beckman's OEM sales. And he has sent regional sales managers to their territories; under SmithKline, they attempted to cover America from headquarters.

Distributor sales — about 40% of total sales — are getting the treatment, too. BI-ETD has trimmed its distributor locations from about 220 to around 200 nationwide, eliminating one national — Time Electronics, a division of Avnet Inc. — and four regionals, and adding three local distributors that show less inclination to be distracted by sexier semiconductor sales. "Our orientation has to be toward those distributors who are equipped to sell and interested in selling passives," explains Sickler.

Other distributor support includes getting Beckman's regional managers to work with their distributor counterparts and tightly focused quarterly planning sessions for the representatives Beckman uses. "We've been working a lot closer with our distributors to help them manage their inventory levels," adds Moore.

Beckman is also intent on holding prices firm, even though price erosion in its product ranges is still uncomfortably steep. Under tighter pricing-authority levels, BI-ETD salespeople must clear even the smaller orders with their managers if deep discounts are demanded. The rationale is that no matter how tempting it may be to follow the pricing spiral downward in a bid to fill up the factory, the brakes must be applied for the long-term good of the industry.

This policy has already cost Beckman plenty. A peripherals maker with a $450,000 order to place recently demanded a 20% discount. Beckman declined, but got 25% of the business anyway at slightly higher prices. It also shunned $85,000 in telecommunications business when required to drop prices another 12%.

Distributors love the new Beckman. Says Michael Mills, corporate marketing manager for passive and electromechanical components at Kierulff Electronics: "They're good strong supporters of distribution. They've implemented some very innovative programs." Arrow Electronics Inc. is similarly impressed — enough to double its inventory of Beckman parts.

But market-share jostling will only take Beckman so far. Ultimately, its welfare depends on upturn in the fortunes of its users. Early in 1987, BI-ETD was seeing some pickup at manufacturers of power supplies, computers and peripherals, but nothing from instrumentation. Moore foresees little or no growth in trimmers this year, with perhaps 10% in networks and in microcircuits for the military.

Farther out, Moore pins more hope on budding Far East markets. "We're in the business for the long term," he insists. ☐

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How CFOs view the Tax Reform Act of 1986

The electronics industry may profit from reform, but the economy will suffer, some CFOs claim in an exclusive poll

By Bruce C.P. Rayner

For chief financial officers and vice presidents for finance, the most common complaint about tax reform is that it makes tax planning more uncertain. While the Internal Revenue Service cranks out explanations and updates of explanations concerning the new legislation, accountants are scrambling to get up to speed on the new bill so they can advise their clients.

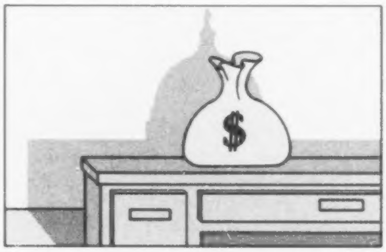
"From the point of view of the corporate taxpayer things certainly didn't get simpler. They got more complicated," says John Rogers, chief financial officer at Zytec Corp., a $50 million power supply maker based in Minneapolis. The problem now is how do companies deal with the added complexity and increased uncertainty?

Besides the key components of tax reform — including the repeal of the investment tax credit (ITC), the higher capital gains tax rate and the lower corporate tax rate — there are many aspects of the new bill that are certain to influence corporate decision making. Affected are corporate structure, employee compensation packages, leasing arrangements and international business practices.

"Every day I read something new [about the tax act] that I didn't know before," comments William Whitehead, vice president for finance at Vectran Corp. a Pittsburgh-based maker of radio data terminals used in real-time warehousing and inventory control. Whitehead complains that because it is so hard to get all the facts, much of the bill is still up for interpretation, "It is going to be more complicated for individuals and will create additional costs for businesses."

But, despite the added uncertainty and the fact that industry must bear the brunt of revenue generation under tax reform, many chief financial officers in the electronics industry believe the short-term effects of tax reform will be minimal. This optimistic outlook implies that financial executives expect the good to outweigh the bad.

This optimism was reflected in a recent poll, conducted by ELECTRONIC BUSINESS, of 73 chief financial officers, vice presidents for finance and controllers. Of those surveyed, 57% came from companies with under $20 million in sales for 1986.



The key components of tax reform for high tech include repeal of the investment tax credit, higher capital gains and a lower corporate tax rate

Surprisingly, over 50% of the respondents expect their corporate after-tax profits to increase in 1988, 1989 and 1990. At the same time, 77% believe that economy-wide capital spending will decrease, and 45% think the federal budget deficit will get worse.

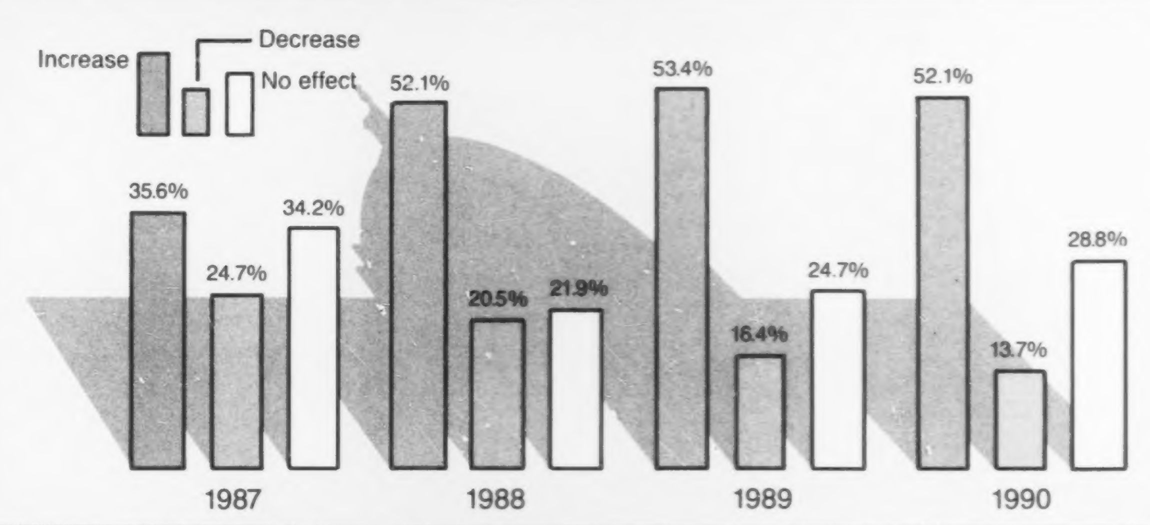
The consensus of those surveyed was that the lower corporate tax rate and the extension of the research and experimentation (R&E) tax credit are the most tangible benefits of tax reform for high-tech companies. Respondents also agreed that the stretching out of depreciation schedules for some equipment and the repeal of the ITC will be the most damaging to corporate health. Two other major changes in the tax code — the increase in the capital gains tax rate from 20% to 28% and the changes in relative international tax rates — are not expected to affect electronics companies one way or the other, respondents said.

The AMT complex

One source of added complexity in the new bill is the calculation of the alternative minimum tax (AMT), a 20% tax on income, plus certain deductibles, deferrals and tax preferences that a corporation is required to pay if it exceeds the regular tax calculation. This new provision also requires corporations to keep an additional set of books. Despite the adverse effects the AMT is expected to have, 60% of the respondents said the AMT will have a neutral impact on their companies, and only 29% said it would have a negative effect.

Harvey Fireman, senior tax manager at Ernst & Whinney, a Big Eight accounting firm, calls the AMT a "pervasive change" in the tax code. "Just by the nature of having to keep a separate set of books for alternative minimum taxable income is just enormously complex," Fireman says. Nearly 51% of respondents said the AMT will increase the number of man-hours needed to calculate the additional tax, but only 27% expect the

The Tax Reform Act of 1986 will generally have what overall result on your company's net after-tax profits in the following calendar years?



For 1987, 57% of all industrial-based computer systems companies expect their profits to decline as a result of tax reform, while 83% of the semiconductor manufacturers surveyed expect no change.

AMT to increase their tax burden.

Fernando Sanchez, controller, manufacturing operations, at Racal-Milgo Inc., a Sunrise, Florida-based maker of communications equipment, says that his company has done some preliminary studies but nothing is conclusive yet. The AMT calculation is going to require more administrative work, he says, but it is uncertain if there is going to be any impact on the company's tax burden. "You can talk to three experts and get five different opinions," he quips.

Abe Schneier, legislative representative for the National Federation of Independent Business, agrees the AMT introduces added uncertainty and complexity. Most smaller firms do not know what it means yet, and so many of them are not even planning for the AMT, he says. Even though the new legislation is in place, the rules are still being debated, making long-term planning impossible.

More than anything else, Schneier comments, the increased record-keeping burden is extremely unfair to smaller businesses. One financial vice president of a small West Coast start-up company says that he still does not know what the AMT means for his business. He said, prior to filing, that he will probably pay someone else to calculate it when the time comes.

"The clerical effort is going to be increased as a result [of the AMT], there is no doubt about that," says Kevin Walsh, controller of the Schlumberger Computer Aided Systems (CAS) group of Schlumberger Ltd. He scoffs at the notion that tax simplification was once one of the objectives of the new legislation.

No one else is laughing either. "The AMT may very well take away some of the tax benefits that we were looking at as perhaps the only silver lining of having had a loss in one year," says Rogers of Zytec, a 3-year-old company that earlier had suffered through some tough financial times. "We might have to pay, or pay more than we otherwise might have done," he adds. As for the added man-hours required to calculate the AMT, Rogers comments that, because Zytec does not have a big staff, adding a couple hundred hours of work will be a costly and painful process.

S corporation deflated

One structural change that could have a significant effect on the revenue-generating potential of tax reform is the decision by closely held corporations to opt for S corporation status. Under this corporate form, the AMT is not applicable and income is taxed only once at the shareholder level. Also, with the repeal of the General Utilities doctrine — requiring liquidating corporations to pay tax on the distribution of appreciated property — S corporation status becomes more appealing.

Toward the end of 1986, when accountants were recommending that clients look at adopting S corporation status, many expected a surge in the conversion rate. But the stampede never materialized — or at least there is no documentation to indicate that it happened. The hesitancy was put down to the uncertainty in the market.

Only 15% of those surveyed said that they considered some form of restructuring in 1986. Of that number, 9% actually adopted S corporation status and another 9% opted for a Master Limited Partnership. An MLP is a reconfiguration of a corporation to make the investors shareholders and any income generated becomes taxable at the lower personal tax rate. Although more complex and time consuming to arrange, the MLP structure will become more popular in the future, says Fireman of Ernst & Whinney. The Boston Celtics basketball team is an MPL.

Another 55% of those that considered restructuring in 1986 said they would consider a change in either 1987 or 1988. Extrapolating from these results, S corporations or MLPs will no doubt become more numerous. The implications of what this means for generating federal tax revenue, however, remain unclear. But it could mean that revenue neutrality, as projected by Congress, might be less likely.

Whitehead of Vectran says that his company considered S corporation status but has not acted on it yet, partly because the regulations are still "up in the air." He says Vectran will look at it again down the road when the tax rules are clearer. An added bonus of S corporation status, Whitehead points out, is that it is as equally applicable to state income tax as it is to federal income tax. In Pennsylvania, where Vectran is located and where the difference between the corporate income tax rate and the individual tax rate was over 7% in 1986, the advantages of S corporation status need little justification.

Effect on leasing

For those that lease plant and equipment, the cost of leasing is expected to increase because of the repeal of the ITC and the possible rise in interest rates later this year. Two-thirds of those surveyed said that they leased plant and equipment in 1986, and most of them are not anticipating any change in their leasing activity in the near term. This is because most leasing contracts are long term in nature and are based on economic contraints, rather than tax considerations. The higher cost of leasing will either be absorbed or passed on to customers.

For a company like Racal-Milgo, which does a substantial amount of its business in leasing equipment, a static change like tax reform will cause changes only after one or two years, says controller Sanchez. Because of the structure of the tax code in the past, Racal-Milgo was able to record the depreciation against the lease income for tax purposes and therefore report losses. Until the lease base is large enough to cover the overhead, he says, Racal-Milgo will continue to report to the IRS in this fashion. But Sanchez fears the possible adverse effects the AMT will have on the company's growing lease business.

Schlumberger's Walsh does not see tax reform having an impact on his company's leasing arrangements, which he claims are relatively small, nor does he expect tax reform to influence the leasing decision of his customers. Economic considerations are more important, he says. "[Many customers] just don't have the cash flow to get into heavy capital equipment investment," he comments. Leasing is a method to ease cash-flow problems rather than one of looking for a lower cost of capital. In this capacity, tax considerations take a backseat to economic necessity.

As for how people will get paid, the use of 401(k)s and incentive stock options (ISOs) are still expected to be popular, but cash will play an increasingly important role in compensation

As a result of tax reform, how will the following factors at your company be changed in 1987?

	Increase	Decrease	No change	Don't know
Profitability	34.2%	26.0%	38.4%	0.0%
Taxes	27.4%	45.2%	26.0%	0.0%
Capital spending	0.0%	27.4%	69.9%	1.4%
Leasing equipment	12.3%	5.5%	78.1%	1.4%
International business	2.7%	4.1%	82.2%	9.6%
Domestic business	4.1%	20.5%	64.4%	9.6%

How will the following factors be affected in 1987 by the Tax Reform Act of 1986?

	Increase	Decrease	No effect	Don't know
GNP growth	24.7%	23.3%	27.4%	23.3%
Interest rates	12.3%	38.4%	24.7%	23.3%
Capital spending	11.0%	76.7%	6.8%	4.1%
Federal budget deficit	45.2%	9.6%	31.5%	12.3%

Indicate what influence the following changes in the tax code will have on your company:

	Very positive effect	Positive effect	Neutral effect	Negative effect	Very negative effect
Capital gains tax increase	0.0%	0.0%	71.2%	17.8%	9.6%
Depreciation schedule changes	0.0%	5.5%	38.4%	50.7%	1.4%
ITC repeal	0.0%	0.0%	12.3%	60.3%	26.0%
R&E credit extension	15.1%	57.5%	21.9%	4.1%	0%
Corporate tax rate decrease	24.7%	53.4%	17.8%	1.4%	1.4%
AMT requirement	0%	0%	60.3%	28.8%	6.8%
Employee compensation changes	0%	4.1%	46.6%	45.2%	1.4%
International tax changes	0%	2.7%	76.7%	13.7%	1.4%

In 1986, did your company consider restructuring under a Subchapter S election, a Master Limited Partnership of any other corporate form as a response to the change in the tax code?

Yes	15.1%
No	83.5%

Will tax reform affect your company's intention to consider mergers or acquisitions now that the Net Operating Loss (NOL) restrictions — not allowing carryovers of NOLs following a 50% change in ownership — have been put in place?

Yes	23%	**Not considering any mergers or acquisitions**	41%
No	36%		

Do you expect to continue to use subcontractors as a result of the change in Section 1706 of the tax code?

Yes	47%	**Don't know**	28%
No	25%		

Source: ELECTRONIC BUSINESS

packages. Seventy-seven percent of those surveyed said that they use some type of noncash compensation for employees but only 69% said that they will continue to use it. Seventy-four percent said that they expect cash to become a more desirable compensation alternative.

Many companies say they will play a neutral role in deciding how employees will be compensated now that the tax advantages of capital payments have been removed by the rise in the capital gains tax rate. Start-up companies in need of attracting high-caliber executives will be the hardest hit in this area.

Rodger Barkus, vice president at Analogy Inc., a Beaverton, Oregon-based computer-aided engineering software company, believes incentive stock options are not as attractive as they were prior to tax reform. But, even though cash will become more desirable, Analogy will focus on "sweetening the pot" with equity to attract good people, says Barkus.

The survey also indicates there is a possibility that merger and acquisition activity will be curtailed because the net operating losses of acquired companies can no longer be applied to tax bills. Twenty-three percent of respondents indicated that the net operating loss (NOL) restrictions — limitations on the use of NOL carryovers that can be used against the acquiring company's tax bill — will affect their acquisition decisions, while 36% said it will not.

Whitehead of Vectran believes that the limitations on using NOLs will effectively eliminate any acquisitions made strictly for the reason of tax breaks. In the past, acquisitions were made for two reasons, he says: to acquire technology or to save taxes. The new law now reduces the value of a prospective buy-out because the tax savings have evaporated. This is particularly relevant for start-up companies that have been desirable as tax-shelter takeovers in the past. As an alternative, joint ventures are expected to become more appealing.

The NOL changes are particularly relevant for the fragmented power supply business, says Zytec's Rogers. "In our position of being relatively young, [the NOL restriction] is going to be a big negative." Small power supply manufacturers struggling with losses now become less attractive.

On the international side of business, only 6% of the respondents expect any change in overseas activity as a result of tax reform, while 80% say there will be no change. Many argue it is still too soon to judge what the international consequences of the new tax act will be because there are other issues at play. These include the fall in the value of the dollar and the ongoing trade negotiations between the United States and Japan.

Accountants insist that the international consequences of tax reform are not yet understood. There are many subtle changes — and some not so subtle changes — that will influence where income is declared and even where production will take place. In the long run, issues such as the super royalty tax (giving the IRS the right to revalue the license fee a company charges its foreign buyer whenever it sees fit) and relative changes in international tax rates will play increasingly important roles in business decisions. □

The 1706 battle for independents

There has been a lot of noise from independent software contractors accusing Congress of cutting off their business. By passing the controversial 1706 amendment to the 1986 Tax Reform Act, many contractors (including engineers, designers, drafters, computer programmers, systems analysts or other similarly skilled workers) are claiming they are being forced out of business and must now become employees of the companies that use their services.

From the tax reform survey conducted by ELECTRONIC BUSINESS magazine, 41% of those surveyed said that they use subcontractors for software engineering. When asked if section 1706 would affect their use of subcontractors, 47% said yes, 25% said no, and 28% said they were unsure.

One recently formed organization, the Technical Consultants National Association (TECNA), which represents independent high-technology consultants, was so outraged by Congress' actions, it filed a civil lawsuit against James Baker, secretary of the U.S. Department of Treasury and Lawrence B. Gibbs, the commissioner of the Internal Revenue Service. TECNA claims that section 1706 will "drive thousands of small- to medium-sized high-technology firms out of business and have a disastrous effect on the technological growth in the United States." By press time, neither Baker nor Gibbs had responded to TECNA's lawsuit, according to TECNA's New England lawyer, Francis M. Lynch.

Section 1706 is intended to introduce fairness into the tax code and to weed out those subcontractors that are abusing their status — independent contractors that work side by side with employees for long periods of time, but because of their status, receive more compensation for their work. As the argument goes, if they cannot pass a 20-question IRS qualifying test, their status should be changed to either an employee of the company that they are working for or an employee of a third-party professional services company.

Because of the confusion that section 1706 created, the IRS gave a grace period until March 31, 1987 for companies to clean up their subcontractor relationships. Now, if a company is audited and found wanting, it is responsible for paying back-taxes on its subcontractors and could be subjected to a fine.

Recommendations for confused chief financial officers from ADAPSO, the computer software and services industry association, is straightforward. If you have doubts about subcontracting, ADAPSO says:

- Ask to see the subcontractor's SS8 form — the IRS's statement that the consultant/contractor/subcontractor passed the 20-question qualifying test. Be sure it is a recent ruling
- If the relationship is expected to be a long-term one, contact the IRS and see if the contractor can be legitimately considered a contractor
- If the consultant works for a third-party broker or services company, ask to see that company's W2 form that states the person you are hiring is an employee of that third-party company.

CMOS acceptance spawns complementary markets

As CMOS technology has moved into more and more segments, chips using the process have become a $5.5 billion business

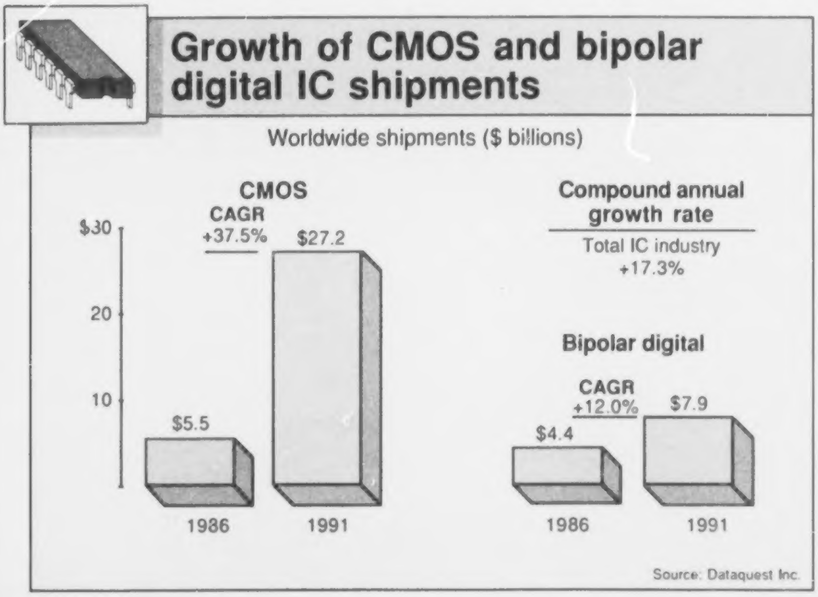
By Valerie Rice

Since its inception in the RCA Corp. laboratories in the 1960s, the CMOS fabrication process has overpowered competitive processes by offering low power consumption and high circuit density. The twin advantages of CMOS have driven complementary metal-oxide semiconductors into every major market sector for a total $5.5 billion in business. New flavors of CMOS are now challenging the segments once thought untouchable.

Semiconductor product managers and buyers agree that CMOS is the favored process for all but the very high-end products. CMOS nay-sayers have vanished, and even bipolar strongholds Texas Instruments and Signetics Corp. have gone CMOS.

The controversies generated about CMOS have withered. Arguments that the process was too slow, that it encountered continual problems and that the chips were unavailable have been refuted. Technological advances overcame most of the objections and CMOS now offers competitive circuit speed for most applications. CMOS also has consistently low-power requirements, high circuit density and a declining price. To sum up, "CMOS is for the masses — it's like rice," says one industry observer.

As further proof of the power of CMOS, some say it is so ingrained as a standard that it has stopped being a technology. "It is no longer an issue of CMOS versus NMOS [n-channel MOS], or even bipolar," Sunnyvale, California-based Signetics Corp. vice president for marketing Thomas Humphrey says. "It is less a matter of demand for the CMOS technology than for newer products," he says. "The market wants newer products and CMOS is the best way to achieve those newer products. It's hardly a matter of choosing a technology anymore. Rather it's choosing functionality, performance and price."



Growth of CMOS and bipolar digital IC shipments

Source: Dataquest Inc.

The market size

The numbers behind the phenomenal growth of CMOS support this contention. According to market research firm Dataquest Inc., San Jose, Calif., the CMOS market grew from $1.1 billion in 1981 to $5.5 billion at the end of 1986. It is predicted to grow to $27.2 billion by 1991 with a compound annual growth rate of 37.5% from 1986, a figure that is more than double the growth rate of the industry as a whole. For comparison, bipolar digital is expected to grow at a compound annual growth rate of only 12% during the same time period.

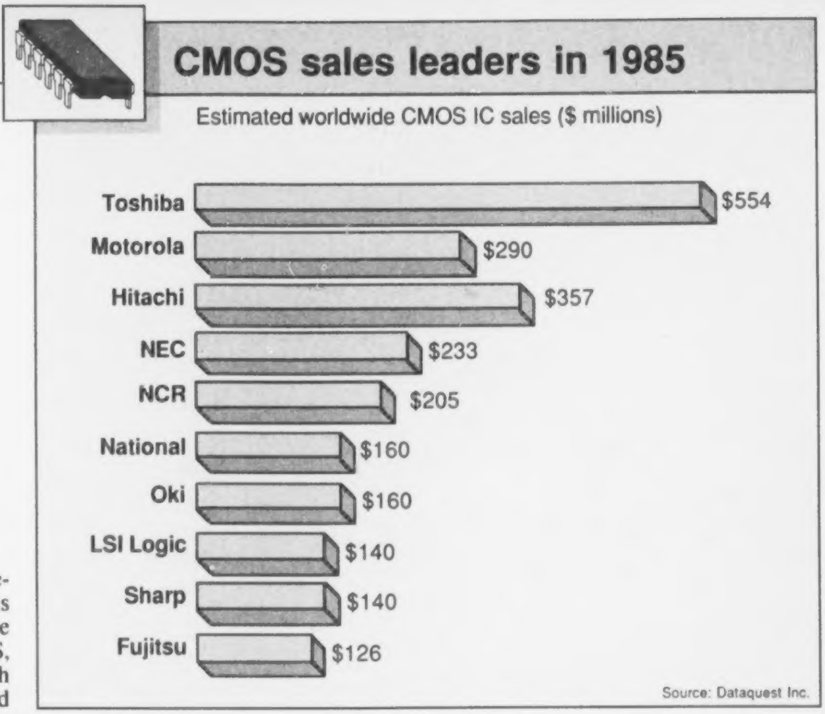
Market research firm In-Stat Inc.'s vice president for technology Bill Groves is more succint: "CMOS gets all the attention and research and development. As far as bipolar is concerned, you can't squeeze blood from a stone."

In terms of market share, Dataquest estimates that MOS products (43% are CMOS) outpaced bipolar digital products in 1986 in the data-processing, communications, consumer electronics and transportation segments of the market. This should come as no surprise since many of these applications — particularly communications, automotive and consumer electronics — require low power consumption and have limited battery capabilities.

The reasons supporting this explosive market growth are numerous. Technically, CMOS offers low power requirements, allowing higher circuit densities and more transistors on a single chip than possible with the bi-

CMOS sales leaders in 1985

Estimated worldwide CMOS IC sales ($ millions)



Source: Dataquest Inc.

polar process. Applications that require low power consumption (such as portable computers or satellites) are built on CMOS foundations. CMOS, with its ability to support a very high density of circuits, has also allowed applications to grow increasingly complex. As an example, Fujitsu America Inc. of San Jose has plans to release a 32-bit chip with between 650,000 and 750,000 transistors, and at the end of this year the next version will hold 850,000 transistors. A bipolar chip with that many transistors would "cook in its own juices," Fujitsu executives claim.

Speed, which was once considered a negative in CMOS technology, has now caught up to industry standards and at some levels it approaches that of bipolar. Price, another issue that has slowed the spread of CMOS in the past, is not a problem now, as the price performance ratios between bipolar and CMOS are almost equal. CMOS is still more expensive but offers a much higher and more complex degree of functionality than bipolar. CMOS is also noise immune, making it very suitable for the telecommunications and automobile environments where electrical disturbances and spurious signals can be common.

For all of these reasons, CMOS is the process of choice in the development of new products for virtually every semiconductor manufacturer today. In fact, as research and development progresses, CMOS is entering a number of markets heretofore unheard of, including programmable array logic (PAL), linear, erasable programmable read-only memory (EPROMs) and microprocessors, as well as old standbys such as controllers and application-specific integrated circuits (ASICs).

It is so widespread that many companies are manufacturing all of their new products in only CMOS, including NCR Corp. of Dayton, Ohio, and the microprocessor division of Intel in Santa Clara, Calif. A majority of other companies are finding that CMOS has opened new market niches for them and their customers, and they are planning to capitalize on that in the future with new and advanced product introductions in CMOS.

The statistics

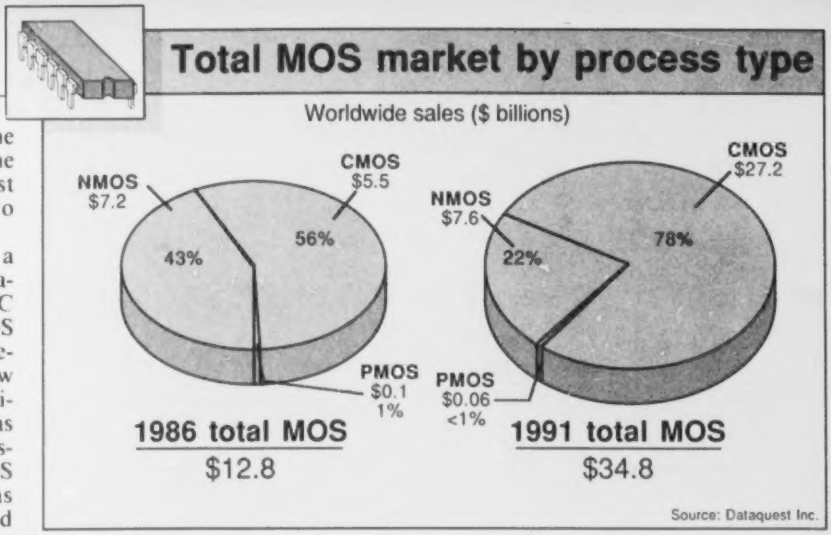
The breadth of CMOS penetration is considerable:

- Twenty-five percent of Intel's automotive division is CMOS. In 18 months or less, executives are predicting 75% will be CMOS
- Delco Electronics Corp., Kokomo, Ind., a captive supplier for General Motors Corp., and a merchant in its own right, currently manufactures 15% to 20% of its products in CMOS, but will have 45% to 50% in CMOS by 1995
- National Semiconductor in Santa Clara produces not more than 50% of its product line in CMOS, but anticipates that about 80% of its products will be in CMOS by the early 1990s
- Although Signetics has only 5% of its products in CMOS today, it plans to double that percentage every year until the end of the decade
- Ford Motor Co., Dearborn, Mich., buys all of its new custom MOS products in CMOS, and most of its microprocessor products are — or will be — in CMOS
- Wyle Distributors, Irvine, Calif., does 90% of its semicustom IC division's business in CMOS.

CMOS is the process of choice in the development of new products for virtually every semiconductor manufacturer today

The deepening market penetration of CMOS goes beyond just new markets and products however, as semiconductor vendors are realizing that CMOS, when applied to "old" technologies, can bring the dead back to life.

Intel's Santa Clara Microcomputer Division marketing manager George Alexy explains that as products reach the last stages of their life cycles, they become more appealing in CMOS as they begin to attract lower end markets. At Intel, the 8088 and 8086 microprocessors were moved to CMOS from their original NMOS, and this is directly on track with their move from the office to the factory floor. For Alexy, this is purely a question of timing. "Where you have more mature products with a lower cost, they can be applied to a whole new wave of applications. These low-end markets are more cost sensitive, so [moving] the 80286 and 80186 [to CMOS from NMOS] would be overkill in terms of performance. Also, because these [low-end] markets are cost sensitive



Total MOS market by process type

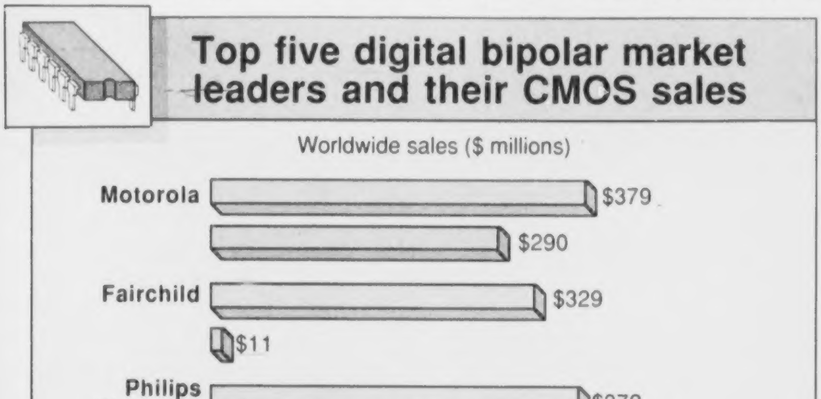
Source: Dataquest Inc.

they look for CMOS because of the lower power and the cooling. By the time the 186/286 are in this cost curve, they too will be moved to CMOS."

Another area that CMOS has had a great effect on is ASICs, where National's vice president of the ASIC Division, Fred Horn, says "CMOS makes ASICs possible." The extremely high density combined with the low power offers the designer the flexibility to pick the power and the speed, as well as pack the chip full of transistors, Horn says. This makes CMOS the logical ASIC process and has helped push Fujitsu, LSI Logic and National into the top 10 CMOS producers at the end of 1985, according to Dataquest. In-Stat estimates that the MOS content in ASICs/gate arrays will grow from $900 million dollars at the end of 1986 to $2 billion in 1990, and the majority of those dollars will be in CMOS.

Fujitsu has been in the CMOS ASICs business since the mid-1970s. According to CMOS products marketing manager Cliff Vaughan, CMOS was the first process Fujitsu used, then the company followed the market into HCMOS, a high performance version of NMOS designed by Intel. Now Fujitsu is back into pure CMOS ASICs products, and the reasons are clear. Says Vaughan, "CMOS is tolerant. It offers fairly high logic densities, and you can pack more gates per chip than anything else." Also, manufacturing is streamlined within Fujitsu because so many of the different product groups have a heavy reliance on CMOS as well, Vaughan says.

CMOS is making inroads in the combination of digital and analog. Analog, which up until recently has been the province of linear circuits, is now finding new market applications in CMOS, a move that is expanding the market, according to analysts at Integrated Circuit Engineering, a Scottsdale, Arizona-based market research firm. ICE studies show that the low power consumption offered to digital functions from CMOS is also available to analog, which will become increasingly more important to vendors over time. ICE, banking on the continuing trend toward "CMOS only" systems, is forecasting a 37% average annual growth rate over the next five years for CMOS analog ICs.



Top five digital bipolar market leaders and their CMOS sales

Source: Dataquest Inc.

CMOS and bipolar

CMOS and bipolar are also moving closer together. Texas Instrument's Richard Moore, new product engineering manager, says it well. "There is a merge of technologies going on between CMOS and bipolar. We have a BiCMOS logic product line, and it is obvious that each technology brings something to the market. They can complement each other and coexist."

But, if some companies have their way, CMOS will be crowded out in the future by BiCMOS. Offering the so-called best of both worlds, BiCMOS lets designers have the low power and high density aspects of CMOS and the high speed of bipolar. But the controversy rages among vendors as to the actual potential of this product.

Edward Browder, president of Saratoga Semiconductor, a San Jose-based maker of BiCMOS-only emitter-coupled logic (ECL) and transistor-transistor logic (TTL) parts, believes that the increasing demand for speed among system designers will quickly spread the popularity of BiCMOS products across a wide number of markets. "BiCMOS is on the leading edge of speed," he says, "and the demand will be for faster parts, not necessarily because the parts are BiCMOS." But Beaverton, Oregon-based Lattice Semiconductor Corp. president C. Norman Winningstad disagrees. "BiCMOS is a restricted market, a niche market," he says. "You don't always have a need for fantastic speed and output. I don't think the extra cost will justify the product enough to spread it over a broad spectrum of markets."

Although CMOS is practically the de facto standard process for many products, other processes have continued to grow. Bipolar, for example, historically offered a designer high speed, particularly in the driver area, although it required large amounts of power and cooling. "When you want an application to be really fast today, you have to have speed, you have to choose bipolar," Lattice's Winningstad says. Bipolar is still the process of choice for the very fast, high-end TTL and ECL environments.

Dramatic speed and density increases in recent years have also given CMOS a price performance ratio very similar to that of bipolar. Bipolar is still cheaper, Dataquest's senior industry analyst Andrew Prophet says, but it is less bang for the buck. Other MOS technologies operating in the same arena as CMOS are NMOS and p-channel MOS (PMOS). By all accounts, PMOS is a dead technology, or will be by the early 1990s. According to Dataquest, PMOS has only a $1 million share of the overall MOS market today and will have a $600,000 share in 1991. NMOS, on the other hand, is at least holding its own in the short term.

Companies like Intel have made heavy investments in NMOS, and have been relatively slow in moving over to CMOS technology. In fact, Intel's automotive group does 75% of its business in HMOS (NMOS). The reason, automotive strategic marketing manager Fred Phail hastens to explain, is that Intel's largest customer, Ford Motor Co., has ordered more than one million engine control units from Intel in HMOS. Phail says that over the next 18 months the products will be converted to CMOS and, at that point, more than 75% of his business should be CMOS. ☐

Get the long cord

When you send a satellite into space, the extension cord just gets longer and longer. This is why, says a TRW spokesperson, the company liked CMOS. Because the military's satellites are so far out they require low power consumption, high density and low cooling requirements. "CMOS has opened new markets for us," Hughes Microelectronics Center's semiconductor products marketing manager Carroll Perkins says. "In digital signal processing in particular, where there are requirements for complex logic, CMOS has opened up quite a few new markets."

According to Integrated Circuit Engineering (ICE), a Scottsdale, Arizona-based market research firm, 25% of the military market at the end of 1986 was CMOS, and by 1988 use of CMOS logic will increase by 15%, and memory will increase by over 20%.

Intel Corp.'s marketing manager for military applications, Robert Singer, targets four main military markets that are well-suited to CMOS. They are communications, command, control and guidance which take CMOS capabilities out to the battlefield where the requirements are for low standby power; electronic warfare systems — including jammers and electromagnetic systems for aircraft — which have to be both low power and highly reliable, as well as radiation tolerant; airborne radar, which have to be low power; and missiles, which have limited space so the density has to be high and the power consumption has to be low.

Despite the Electronic Industry Association's predictions of flat growth for the military market until the end of the decade, a number of vendors find selling CMOS products to the military a stable business. Hughes Microelectronics Center does 90% of its business for the military (including 10% that is captively sold to Hughes Aircraft), and 95% of the shipments are CMOS. Intel currently produces about 35% of its military products in CMOS, and it has been up over 20% in the last few years; Singer predicts that by the end of the decade, 75% of Intel's products will use CMOS. There are several reasons for this, he says. "The biggest drive right now is the introduction of newer, more complicated, powerful products, like the 80386, which has 350,000 transistors on it. We can't do that in HMOS because there is too much power output."

International Device Technology, a San Jose, California-based semiconductor manufacturer, views the military market as one of the most regular buyers of its CMOS-only products. "The military market has had a stabilizing influence on our growth," marketing vice president William Snow says. IDT sells CMOS static RAMs into the military market and has found the military moving from NMOS to CMOS at about the same rate as the commercial market.

RCA Corp. estimates that it has a 50% to 60% share of the CMOS military market, which is fitting since it considers CMOS its "birthright." RCA developed CMOS in its Princeton, N.J., laboratories in the 1960s and has been manufacturing in CMOS ever since.

Another trend Intel's Singer notes is that as military suppliers integrate CMOS processors into their systems, they want the memory and peripheral products moved to CMOS as well. This helps insure a continuing business for CMOS products in the military, Singer says.

One of the biggest problems military developers must face, however, is making CMOS radiation hard. "The only semiconductor technology that is technically softer than CMOS is NMOS," ROLM Mil-Spec Computer's manager of hardware product marketing William Morrison says. "Bipolar is naturally much harder."

The problems with radiation hardness occur in two ways and at three different levels, according to ROLM executives. In space, there is a degree of natural radiation or ionization that takes place, and companies that build satellites, such as TRW, have to protect against space radiation. ROLM, which builds earth-based systems, must plan for a grimmer future: nuclear war.

"In a tactical nuclear environment, electromagnetic pulses occur, and they have a different effect than space ionization," Morrison said. "Although levels of radiation hardness are coming up in CMOS, you still have to protect against three different levels of radiation, including neutrons, and two levels of gamma rays."

IDT is currently involved in a research and development effort to "build a technology that is truly rad hard," Snow says. ☐

Venture capital: Knowing when the price is right

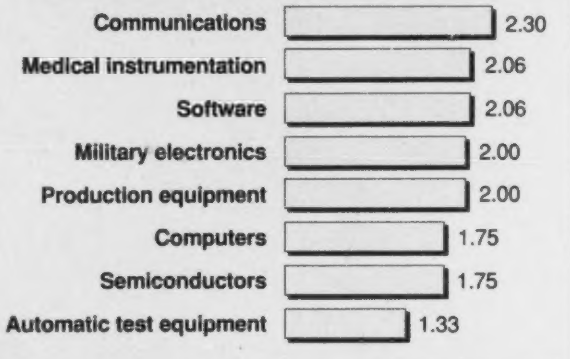
Venture capitalists say there's still plenty of money available for start-up electronics firms in uncrowded niches

By Bruce C.P. Rayner

Since the downturn in 1985, just being a high-tech firm is no longer enough to ensure backing from a venture capitalist. The stakes have been raised and the investors are more discerning. To be convincing today, a company needs a niche market and a competent managerial team to exploit it. For entrepreneurs that can satisfy these criteria, the money is there.

A recent poll of 45 venture capital firms by ELECTRONIC BUSINESS magazine — which we believe is 95% accurate, plus or minus 3% — confirms these findings. Of those polled, 78% described the outlook for the computer and electronics industry in the second half of 1987 as "good" or "excellent." Only 22% said the outlook was "average." And none characterized the outlook as "poor." Of the industry sectors that are experiencing the highest start-up activity this year, communication equipment was singled out most frequently. Medical instrumentation and software start-ups also fared well. (The poll is based on a questionnaire mailed to 465 venture capitalists earlier this year; the response rate was 10%.)

What sectors of the industry do you expect will experience the highest rate of start-up activity this year?



Respondents were asked to rank sectors in order of importance (3 = most important; 2 = moderately important; 1 = least important)

Source: ELECTRONIC BUSINESS

But what the poll does not reflect is what's good for venture capital is not always good for management. In terms of pricing, for example, most venture capitalists think the costs of investments are currently good. The valuation of many publicly traded electronics companies, venture capitalists say, has stayed down chiefly because the industry had a bad year in 1986. But with a generally bullish stock market, those values are creeping up, and with them, the value of privately held, venture-backed companies.

But despite the low valuations of electronics stock, the number of initial public offerings (IPOs) more than doubled in 1986 to 97, up from 46 in 1985, reports Venture Economics Inc., a market research firm in Wellesley, Mass. Although there is some concern that these IPOs may have been undervalued, it is one way venture capitalists cash in.

Acquisitions were also up in 1986 to an estimated 120, almost reaching the 1983 record of 121. Part of the reason for the mushrooming could be attributed to the pending tax reform and part to the undervaluation of the investments in a depressed market.

Charles J. Coulter, president of American Research & Development Inc. (ARD), the Boston-based venture capital firm, believes that pricing now is "realistic." In the early part of the decade, he says, the valuation of some of these high-tech companies was way out of hand. "I don't think they are low and I don't think they are too high. I think they are probably just right," he comments.

Anthony M. Lamport, a managing director at Drexel, Burnham Lambert Inc. in New York, a firm that manages a $40 million venture capital fund, believes that IPOs will be strong in 1987. He says there is "a big rush" of companies filing to go public because they see the market improving. "It takes awhile before they become public," he comments, "but you will see a lot of them in the next few months."

Gourd rattling

Whether valuation will pick up this year will depend largely on the performance of the electronics industry. As one venture capitalist quips: "We are praying and hoping, shaking beads and rattling gourds to make the situation turn around in 1987." But more than voodoo is needed to return the venture capital market to top health. What many are relying on is a more discriminating assessment of potential ventures. As Stanley E. Pratt, chairman of Venture Economics, says: "Venture capitalists are paying a great deal more attention toward the basics of the business." ▷

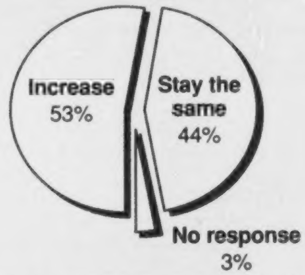
Those basics, Pratt says, are driven by market opportunities and not the technology of the product. "Where venture capitalists really want to invest is in a small niche that clearly meets a market need." Where they went wrong in the past, he adds, is they chased technology for the sake of technology. They need to do their homework better and cull out those that will be successful, preferably in uncrowded niche markets, he advises.

Everyone in the business has their own strategy for picking the winners: Coulter of ARD looks for long-term investments in an emerging or core technology and a proprietary method; Sigmund E. Herzstein, an investment manager at Arthur D. Little Ventures, a limited partnership in Cambridge, Mass., that has Arthur D. Little Inc. as an investor, says he looks for very strong individuals with good credentials and a track record in their industry combined with a product with a "fairly high technical contribution."

What venture capitalists shy away from is a focus on a segment of the industry. Instead, most attempt to evaluate potential investments on a case-by-case basis. Mainstream semiconductor and computer companies are viewed with disdain, notes James Fitzpatrick, a senior vice president with General Electric Venture Capital Corp. in Westport, Conn. Fitzpatrick singles out the communications field — specifically in Ku-band satellites and fiber optics for local area networks — as one of the bright spots in an otherwise lackluster field.

"Broadly speaking, communications is still a hot area," Pratt concurs. But he warns that it is not the technology that is the central attraction; it is how that technology is used to fulfill market needs. "We have a saying in venture capital," he says: "You can match a first-rate management team with a second-rate product and have success, but you can almost never have success when you back a second-rate management team with a first-rate product."

In 1987, will your investment in electronics companies:



Significantly, none of the respondents said electronics investments would decrease. And 69% said overall investments, which include nonelectronics companies, would increase in 1987

Tax impact

Meanwhile, the changing tax climate is also having an impact on the ability of start-up electronics companies to attract venture capital. Many venture capitalists are worried about the negative impact the Tax Reform Act of 1986 will have on business. Because the capital gains tax rate has been raised from 20% to 28%, riskier investments in early stage start-up companies are less likely to find backing. Junk bonds, in fact, are a safer haven. The higher capital gains rate also means it will be harder to attract top-grade managers to emerging companies, particularly in the later stage of refinancing.

Another aspect of tax reform — the new limitations placed on the use of net operating loss (NOL) carryforwards — now makes the acquisition of companies with bottom-line losses worth less to prospective buyers. Indeed, any significant change in ownership, including refinancing, means that NOLs will become almost useless.

Under the new regulations, losses of companies that change hands can no longer be used to the same extent as before to offset the taxes of acquiring companies. The result could be a significant decline in the value of the company being acquired. This has

1986 top 20 venture capital firms in electronics

Rank	Company name	Location	Total investments in electronics companies ($ millions)	Total portfolio ($ millions)	Total investments ($ millions)
1	**Hambrecht & Quist Venture Partners**	San Francisco, Calif.	$69.8	$600.0	$93.0
2	**Sprout Group**	New York, N.Y.	31.0	120.0	47.0
3	**General Instrument**	New York, N.Y.	30.0	550.0	30.0
4	**Kleiner Perkins Caufield Byers**	San Francisco, Calif.	29.9	386.6	34.1
5	**Oak Investment Partners**	Westport, Conn.	29.0	37.0	34.0
6	**Institutional Venture Partners**	Menlo Park, Calif.	26.0	152.5	29.0
7	**J.H. Whitney & Co.**	New York, N.Y.	23.3	NA	25.4
8	**Brentwood Associates**	Los Angeles, Calif.	23.0	269.0	40.4
9	**Robertson Colman Stephens**	San Francisco, Calif.	22.8	93.0	38.0
10	**First Chicago Venture Capital**	Chicago, Ill.	22.2	61.5	135.0
11	**U.S. Venture Partners**	Menlo Park, Calif.	20.5	171.0	42.1
12	**Merrill Pickard Anderson Eyre**	Palo Alto, Calif.	16.0	180.0	16.0
13	**Mayfield Fund**	Menlo Park, Calif.	13.8	200.0	19.3
14	**GE Venture Capital**	Fairfield, Conn.	13.0	21.0	18.6
15	**Interwest Partners**	Menlo Park, Calif.	13.0	153.0	17.0
16	**Menlo Ventures**	Menlo Park, Calif.	12.5	150.0	15.0
17	**Warburg Pincus Ventures**	New York, N.Y.	12.0	1,600.0	93.8
18	**Montgomery Securities**	San Francisco, Calif.	11.4	96.4	14.0
19	**Dougery Jones and Wilder**	Mountain View, Calif.	11.2	86.0	15.1
20	**Summit Ventures**	Boston, Mass.	11.0	160.0	23.0

NA = Not available

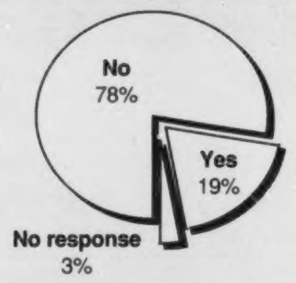
ramifications for companies that are going through the refinancing process, as this is also considered a change in ownership.

All aspects of venture capital are affected, including both investors and entrepreneurs, adds Daniel T. Kingsley, executive director of the Arlington, Virginia-based National Venture Capital Association (NVAC), a trade association for venture capitalists. In the post tax-reform environment, says Kingsley, the question of risk becomes a bigger factor. Although there is no hard data, the NVAC director believes that less risky later-stage financing will become more popular among venture capitalists in the future.

International currency fluctuations and the strategic outlook of large investors toward high-tech firms are also having an impact on the venture capital scene. The weakened dollar, venture capitalists say, is a mixed blessing for the industry, making foreign capital harder to raise, but also opening up foreign markets to U.S. companies. From 1985 to 1986 the share of foreign sources of venture capital dropped from 23% to 11%, reports Venture Economics. This was caused in part by the declining dollar but also because of the increasing importance of pension funds which grew from 33% in 1985 to 49% last year.

Meanwhile, partnership arrangements are expected to play a larger role among start-up firms in the years ahead. These arrangements have been growing in importance for reasons other than tax advantages, but with the new NOL restrictions, they become even more appealing. In a strategic partnership, a large corporation can funnel money into an emerging company without having to take control. The small company benefits by retaining its independence but can tap the financial and marketing strength of its bigger partner. At the same time, the larger company benefits from the proprietary technology the small company offers.

Does your company invest in overseas start-ups?



A third of those polled maintain strategic alliances with overseas venture capital firms.

As an example, Herzstein of ADL Ventures points to a strategic partnership deal his firm has formed with Aeonic Systems Inc. of Billerica, Mass. Aeonic is a 3-year-old company that produces a computer-integrated manufacturing (CIM) control system — software and remote process-control units — for monitoring the production of plastics and paper. In January of this year, Hercules Inc., an aerospace chemical and plastics company based in Wilmington, Del., sank an undisclosed amount into the business, Herzstein says, with the intention of developing Aeonic Systems control system for the paper-processing business. Hercules maintains a minority interest but has the option of increasing its share. The relationship is working well so far, says Herzstein.

James Bourque, vice president for marketing and sales at Aeonic Systems agrees that Hercules made a smart move. By leaving Aeonic intact as a separate entity the incentives for employees are retained and creativity is not stifled. It would have been a mistake to imprint Hercules' corporate style on the budding company, says Bourque. He adds, however, that Aeonic benefits from the resources that Hercules provides.

The ELECTRONIC BUSINESS *venture capital survey, tabulations and directory were compiled by assistant editor Nancy McSharry.*

Electronics investments as a percentage of total investments	Average investment per deal	Average electronics investment per deal	Total number of deals	Total number of deals in electronics companies	Number of deals in electronics companies as a percentage of total deals	Planned investments in 1987 ($ millions)	Preferred stage of investment
75.0%	NA	NA	NA	NA	NA	$69.0	No preference
66.0%	$1,192,308	$5,222,222	26	9	35%	30.0	No preference
100.0%	2,307,692	2,307,692	13	13	100%	NA	No preference
87.7%	1,033,333	1,150,000	33	26	79%	29.0	Seed, first
85.3%	693,878	644,444	49	45	92%	29.0	Seed, first
89.7%	828,571	8,666,667	35	3	9%	28.0	Seed, first
NA	846,667	1,060,000	30	22	73%	30.0	No preference
56.9%	1,010,000	958,333	40	24	60%	37.5	Seed, first, second
60.0%	1,000,000	1,036,364	38	22	58%	27.0	Seed, first
16.4%	1,901,408	854,501	71	26	37%	130.0	Mezzanine, follow-on
48.7%	957,872	855,324	44	24	55%	65.0	No preference
100.0%	761,905	761,905	21	21	100%	15.0	Start-up, seed, first
71.5%	584,848	511,111	33	27	82%	25.0	Start-up, seed, first
69.9%	620,000	619,048	30	21	70%	NA	No preference
76.5%	739,130	866,667	23	15	65%	17.0	Seed, first
83.3%	1,250,000	1,250,000	12	10	83%	2.0	Seed, first, second
12.8%	3,474,074	1,090,909	27	11	41%	NA	Seed, first
81.4%	466,667	518,182	30	22	73%	NA	Seed, mezzanine
74.1%	686,364	746,667	22	15	68%	13.0	Seed, first
47.8%	1,769,231	1,571,429	13	7	54%	25.0	No preference

Source: ELECTRONIC BUSINESS

Who's who in venture capital

Directory of venture capital contacts

	Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
Accel Partners One Palmer Square, Princeton, N.J. 08542 Dickson R. Doll, Arthur C. Patterson, James R. Swartz: (609) 683-4500	$110	$8.6	$7.1	14	12
Adler & Company 375 Park Avenue, Suite 3303, New York, N.Y. 10152 Frederick R. Adler, Yuval Binur, Joy London, Daniel O'Neill, David Blumberg, Gary Grimm, John Hamann, Gill Cogan: (212) 759-2800					
Advanced Technology Ventures 10 Post Office Square, Suite 1230, Boston, Mass. 02109 Albert E. Paladino: (617) 423-4050	$73	$42	$10	16	16
Alan Patricof Associates Inc. 545 Madison Avenue, New York, N.Y. 10022 Kathryn Neal, Rebecca Ryan, Lewis Solomon: (212) 753-6300	$250	$35.8	$4.9	67	19
Al Stern Associates Inc. 1127 So. Patrick Drive, Suite 3, Satellite Beach, Fla. 32937 Al Stern: (305) 777-2018					
Arthur D. Little Ventures L.P. 20 Acorn Park, Cambridge, Mass. 02140 Walter Cairns: (617) 864-5770	$15	$1.8	$1.8	8	8
Asset Management Co. 2275 E. Bayshore Road, Palo Alto, Calif. 94303 John Shock, Craig Taylor: (415) 494-7400	$90	$11	$8	20	15
BancBoston Ventures 100 Federal Street, Boston, Mass. 02110 Paul Hogan: (617) 434-2442	$35	$6.5	$2.5	8	3
Bay Partners 10600 North DeAnza Boulevard, Cupertino, Calif. 95014 G. Hazel: (408) 725-2444	$95	$8	$7.8	10	9
Battery Ventures 200 Portland Street, Boston, Mass. 02114 Howard Anderson, Robert G. Barrett, Richard D. Frisbie, general partners: (617) 367-1011					
Beta Ventures Inc. One Post Office Square, Suite 3800, Boston, Mass. 02109 Frank Kenny: (617) 482-8020	$15	NA	NA	NA	NA
Blalack-Loop Inc. 696 East Colorado Boulevard, Suite 220, Pasadena, Calif. 91101 Charles M. Blalack: (818) 449-3411	NA	$10	$10	3	3
Brentwood Associates 11661 San Vicente Boulevard, Suite 707, Los Angeles, Calif. 90049 G. Bradford Jones, general partner; Leslie R. Shaw, vice president, finance: (213) 826-6581	$269	$40.4	$23	40	24
Bridge Capital Investors 50 Broadway, 29th floor, New York, N.Y. 10004 Alex Jeffers: (212) 514-6700	$100	$22	$3.5	6	2
Burr, Egan, Deleage & Co. One Post Office Square, Suite 3800, Boston, Mass. 02109 Esther Sharp: (617) 482-8020	$10.8	$15.8	$4.8	41	8
CFB Venture Capital 530 B Street, San Diego, Calif. 92112 Richard Roncaglia: (619) 230-3304					
Charles River Ventures 67 Batterymarch Street, Boston, Mass. 02110 (617) 482-9370	$150	$17	$10	8	4
Charter Venture Capital 525 University Avenue, Suite 1500, Palo Alto, Calif. 94301 A. Barr Dolan: (415) 325-6953	NA	NA	NA	14	7

(continued)

	Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
Churchill International 444 Market Street, San Francisco, Calif. 94111 Roy Helsing: (415) 398-7677	$40	$2.2	$2.2	4	4
Comp-U-Net 4350 Palm Avenue, La Mesa, Calif. 92041 Paul Franc: (619) 698-1517					
Coleman Ventures Inc. 5909 Northern Boulevard, East Norwich, N.Y. 11732 Gregory S. Coleman: (516) 626-3642	$1	$0.5	$0.5	2	2
Coronado Venture Fund 800 North Swan, Suite 130, Tucson, Ariz. 85711 James M. Strickland, managing partner: (602) 326-6778	$1.2	$0.4	$0.3	3	2
Corporate Finance Associates Inc. of Georgia 6600 Peachtree Dunwoody Road, Building 300, Suite 670, Atlanta, Ga. 30328 David O. Ellis: (404) 399-5633					
Crosspoint Venture Partners 1951 Landings Drive, Mountain View, Calif. 94043 John B. Mumford: (415) 964-0100	$65	$12	$10.5	10	8
Dajen Corp. 9 Lundy Lane, Larchmont, N.Y. 10538 Robert Cohen: (201) 837-9118; (914) 834-8510					
Dougery, Jones & Wilder 2003 Landings Drive, Mountain View, Calif. 94043 John R. Dougery, David A. Jones, Gerald R. Schoonhoven, Henry L.B. Wilder: (415) 968-4820 Two Lincoln Centre, Suite 1100, 5400 LBJ Freeway, Dallas, Texas 75240 A. Lawson Howard: (214) 960-0077	$86	$15.1	$11.2	22	15
Eastech Management Company Inc. One Liberty Square, 9th floor, Boston, Mass. 02109 Michael H. Shanahan: (617) 338-0200	$34.3	$2.2	$2.2	22	22

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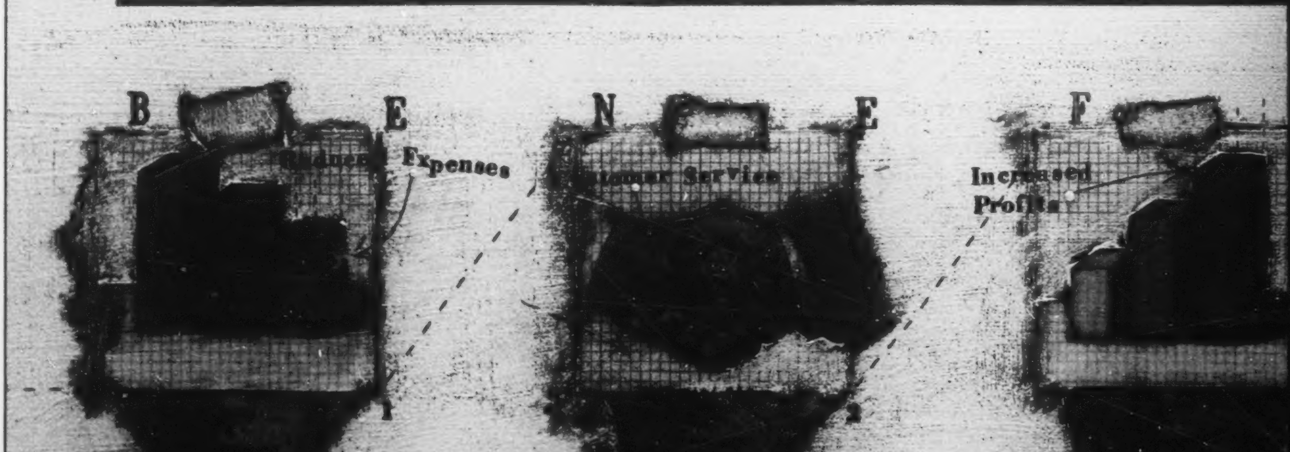

	Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
Fairfield Venture Partners 1275 Summer Street, Stamford, Conn. 06905 Oakes Ames: (203) 358-0255; (714) 754-5717	$100	$12	$8.5	24	14
FBS Venture Capital 6900 E. Camelback Road, #452, Scottsdale, Ariz. 58251 William B. McKee: (602) 941-2160					
First Analysis Management Company 20 North Wacker Drive, Chicago, Ill. 60636 Bret R. Maxwell: (312) 372-3111					
First Boston Venture Capital Park Avenue Plaza, 40th floor, New York, N.Y. 10055 Harold Bogle, Jeffrey Parker: (212) 909-4582	NA	$25.9	$3.5	18	10
First Century Partners 1345 Avenue of the Americas, New York, N.Y. 10105 David S. Lobel, Lisa Roumell, Geoffrey Y. Yang: (212) 698-6383	$150	$15	$10	9	6
First Chicago Venture Capital 3 First National Plaza, Suite 1330, Chicago, Ill. 60670 Kent P. Dauten: (312) 732-5400; Kevin M. McCaffrey: (617) 542-9185	$61.5	$135	$22	71	26
Frontenac Venture Co. 208 South LaSalle Street, Suite 1900, Chicago, Ill. 60604 Martin Koldyke: (312) 368-0044	$182	$18	$1.7	18	5
General Electric Venture Capital 3135 Easton Turnpike, Fairfield, Conn. 06431 (203) 373-3333	$21	$18.6	$13	30	21
General Instrument 767 Fifth Avenue, New York, N.Y. 10153 Edward Keraney: (212) 207-6200	$550	$30	$30	13	13
Grace Ventures Corp. 20300 Stevens Creek Boulevard, Suite 330, Cupertino, Calif. 95014 Christian Horn: (408) 725-0774					

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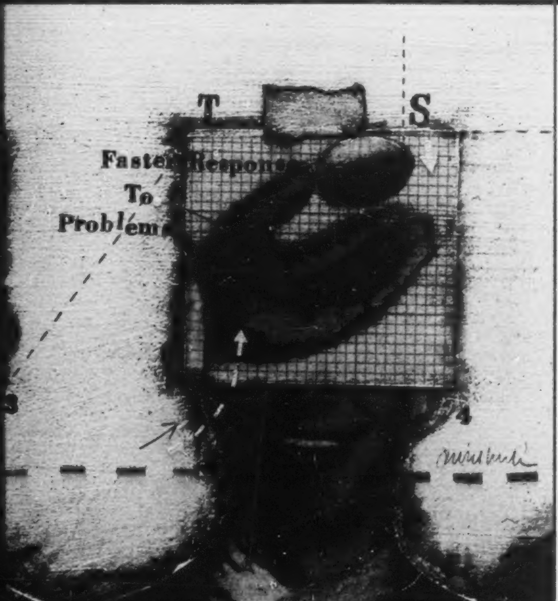

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communications
company ℠

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VENTURE CAPITAL

	Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
Greylock Management 1 Federal Street, Boston, Mass. 02110 Dan Gregory, William Helman: (617) 423-5525	NA	$19.4	$11	26	11
Hambrecht & Quist Venture Partners 235 Montgomery Street, San Francisco, Calif. 94104 Ken Guernsey, Bob Kunze: (415) 986-5500	$600	$93	$69.75	NA	NA
Hambro International Venture Fund 17 East 71st Street, New York, N.Y. 94104 Bob Bertolli, Julie Lane: (212) 288-7778	$80	$15	$7.5	12	6
Happ Ventures 444 Castro Street, Suite 400, Mountain View, Calif. 94041 William D. Happ: (415) 961-1115					
Hill, Kirby & Washing 885 Arapahoe, Boulder, Colo. 80302 John G. Hill, Paul J. Kirby, Thomas G. Washing: (303) 442-5151	$6	$5.8	$0.9	8	3
Inco Venture Capital Management One New York Plaza, New York, N.Y. 10004 Stuart F. Feiner: (212) 612-5620	$70	$10	$3.3	20	11
IndoSuez Technology Group 3000 Sand Hill Road, Building 4, Suite 130, Menlo Park, Calif. 94025 David E. Gold, Phillipe Sevin: (415) 854-0587	$34	$4	$2.8	8	5
Institutional Venture Partners 3000 Sand Hill Road, Building 2, Suite 290, Menlo Park, Calif. 94025 John Poitras: (415) 854-0132	$96	$29	$29	35	35
Intersouth Partners P.O. Box 13546, Research Triangle Park, N.C. 27709 Dennis J. Dougherty: (919) 544-6473					
Interwest Partners 3000 Sand Hill Road, Building 3, Suite 255, Menlo Park, Calif. 95025 Chuck McMinn: (415) 854-8585	$153	$17	$13	23	15
JAFCO America Ventures Inc. 2180 Sand Hill Road, Suite 270, Menlo Park, Calif. 94025 S. Fukada: (415) 854-0746					
J.H. Whitney & Co. 630 Fifth Avenue, New York, N.Y. 10111 Edward V. Ryan: (212) 422-3933	$200	$25.4	$23.2	30	22
Kleiner Perkins Caufield Byers 4 Embarcadero Suite 3520, San Francisco, Calif. 94111 Mike Curry: (415) 421-3110	$386.6	$34.1	$29.9	33	26
The Lambda Funds 55 Broad Street, New York, N.Y. 10004 Alexa Mahnken: (212) 480-5160	$40	$6.1	$4	18	11
Lawrence Venture Associates 515 Madison Avenue, 29th floor, New York, N.Y. 10022 Brian T. Horey: (212) 826-9080	$68	$9	$2.4	10	3
Leverage Inc. 8615 Wild Olive Drive, Potomac, Md. 20854 L. Wasserman: (301) 230-0701					
Matrix Partners One Post Office Square, Suite 3840, Boston, Mass. 02109 W. Michael Humphreys: (617) 482-7735	$115	$16.6	$9.2	25	15
Mayfield Fund 2200 Sand Hill Road, Suite 200, Menlo Park, Calif. 94025 Norman A. Fogelsong: (415) 854-5560	$200	$19.3	$13.8	33	27
MBW Management Inc. 365 South Street, Morristown, N.J. 07960 Philip E. McCarthy, managing director: (201) 285-5533					
Melchor Venture Management 170 State Street, Suite 220, Los Altos, Calif. 94022 Gregory Young: (415) 941-6565					
Menlo Ventures 3000 Sand Hill Road, Bldg. 4, Suite 100, Menlo Park, Calif. 94025 DuBose Montgomery: (415) 854-8540	$150	$15	$12.5	12	10
Merrill Pickard Anderson Eyre 2 Palo Alto Square, Suite 425, Palo Alto, Calif. 94306 Jeff Pickard: (415) 856-8880	$180	$16	$16	21	21
Mesirow Venture Capital 350 N. Clark Street, Chicago, Ill. 60610 James C. Tyree, managing director: (312) 670-6000	$75	$5.75	$1.65	6	1

(continued)

Mitec Ventures
2727 N. Bristol Street, Suite 108, Santa Ana, Calif. 92706
M.L. "Bud" Warrick: (714) 953-2731

Montgomery Securities
600 Montgomery Street, San Francisco, Calif. 94111
James Pelkey: (415) 627-2000

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$96.4	$14	$11.4	30	22

Morgenthaler Venture
700 National City Bank Building, Cleveland, Ohio 44114
Robert C. Bellas Jr.: (216) 621-3070

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$100	$13.9	$5.1	20	9

Morgan Holland Ventures Corp.
One Liberty Square, Boston, Mass. 02109
(617) 423-1765

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$58.6	$6.5	$6	6	5

Morgan Stanley Ventures
101 California Street, San Francisco, Calif. 94111
Robert L. Burr, general partner: (415) 576-2345

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$39.2	$4.5	$4.5	2	2

MSA Ventures
3101 Thistlewood, Thousand Oaks, Calif. 91360
Martin S. Albert: (805) 492-2275

Narragansett Capital Inc.
40 Westminster Street, Providence, R.I. 02903
A.D. Little: (401) 751-1000

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
NA	NA	0	7	0

NEPA Venture Fund L.P.
125 Goodman Drive, Bethlehem, Pa. 18015
Frederick J. Bestelli, Glen R. Bressner: (215) 865-6550

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$11	$0.68	$0.6	2	1

New Venture Development Corp.
1025 Thomas Jefferson, #400 E, Washington, D.C. 20007
David A. Shaw: (202) 944-3636

Oak Investment Partners
257 Riverside Avenue, Westport, Conn. 06880
Ron Verilli: (203) 226-8346

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$37	$34	$29	49	45

Olympic Venture Partners
411 108th Street N.E. Suite 1710, Bellevue, Wash. 98004
George Clute: (206) 455-1470

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$68.4	$5	$5	7	7

Orange Nassau
260 Franklin Street, Suite 1500, Boston, Mass. 02110
(617) 451-6220

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$110	$21	$8.1	11	4

Palmer Partners
300 Unicorn Park, Woburn, Mass. 01801
William H. Congleton, general partner: (617) 933-5445

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$50	$7.6	$5	24	17

The Pittsford Group
8 Lodge Pole Road, Pittsford, N.Y. 14534-3814
Logan M. Cheek III: (716) 223-3523

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$40	$3.5	$1	3	1

(continued)

MENLO VENTURES
3000 Sand Hill Road, Bldg. 4, Suite 100
Menlo Park, CA 94025, 415-854-8540

CONTACTS:
DuBose Montgomery, Ken Joy, Doug Carlisle, Rick Magnuson, Tom Bredt, Denise O'Leary, John Jarve, and Michael Riordan

TYPE OF FIRM:
Private venture capital firm with over $150 million under management.

AFFILIATIONS:
Affiliations with leading institutional investors from corporations, pension funds, insurance companies, banks, and universities.

PREFERRED PROJECTS:
Start-ups, later-stage financings, leverage buyouts.

GEOGRAPHIC PREFERENCE: United States

INDUSTRY SEGMENT PREFERENCE:
Computers, communications, software, medical and other electronic-related industries.

OTHER INFORMATION:
Menlo Ventures has been in business for more than a decade and has successfully financed more than 80 emerging companies in a wide range of industries.

RAYTHEON VENTURES
141 Spring Street
Lexington, MA 02173, 617-860-2270

CONTACTS:
David R.A. Steadman, President
Clyde E. Rettig, Vice President

TYPE OF FIRM:
Corporate venture capital arm investing own funds

AFFILIATIONS:
Raytheon Company

PREFERRED PROJECTS:
Early stage and later high technology/strategic investments

GEOGRAPHIC PREFERENCE:
No preference

INDUSTRY SEGMENT PREFERENCE:
Electronics, computers, communications, semiconductors and other related businesses

Raytheon Ventures
141 Spring Street, Lexington, Mass. 02173
David R.A. Steadman: (617) 860-2270

Regional Financial Enterprises
36 Grove Street, New Canaan, Conn. 06840
George Thomassy: (203) 966-2800

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$142	$50	$10	54	19

Robertson Colman Stephens
One Embarcadero Center, Suite 3100, San Francisco, Calif. 94111
R. Lee Douglas, Gary W. Masner, J. Matthew Mackowski, Paul H. Stephens: (415) 781-9700

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$93	$38	$22.8	38	22

Rothschild Ventures
3000 Sand Hill Road, Building 3, Suite 260, Menlo Park, Calif. 94025
J. Michael Gullard: (415) 854-2576

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$7.3	$2.6	$1	5	3

Security Pacific Capital Corp.
650 Town Center Drive, Costa Mesa, Calif. 92626
Tim Hay: (714) 556-1964

Sierra Ventures
3000 Sand Hill Road, Building 1, Suite 280, Menlo Park, Calif. 94205
Peter Wendell, Vincent Topkin: (415) 854-1000

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$75	$9	$5.5	8	5

Sigma Partners
2099 Gateway, Suite 310, San Jose, Calif. 95110
J. Burgess Jamieson: (408) 279-6300

Southern California Ventures
9920 La Cienega Boulevard, Suite 510, Inglewood, Calif. 90301
Jay Raskin, B. Allen Lay: (213) 216-0544

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$18.95	$2.4	$1.2	3	2

Southwest Venture Partnerships
300 Convent, Suite 1400, San Antonio, Texas 78205
John Long: (512) 227-1010

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$75	$9.7	$1.7	6	1

Sprout Group
140 Broadway, New York, N.Y. 10005
Richard E. Kroon: (212) 504-3600

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$120	$31	$47	26	9

Summit Ventures
One Boston Place, Boston, Mass. 02108
Eric Shealy: (617) 742-5500

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$160	$23	$11	13	7

Sutter Hill Ventures
2 Palo Alto Square, Suite 700, Palo Alto, Calif. 94306
Paul M. Wythes: (415) 493-5600

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$200	$10	$10	8	8

TA Associates
45 Milk Street, Boston, Mass. 02109
Robert W. Daly, C. Kevin Landry, P. Andrews McLane, Jacqueline C. Morby: (617) 574-6715
435 Tasso Street, Suite 200, Palo Alto, Calif. 94301
Jack Bunce, Jeffrey T. Chambers, Michael C. Child: (415) 328-1210

Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
$570	$54	$1.8	37	1

American Electronics Association AEA and **Electronic Business** present:

日本

Japan Electronics:
A Business and Technology Update

The Japan Electronics seminar on October 7 in Osaka is designed to help European and U.S. executives seek out new business opportunities in Japan. The day-long seminar, which will coincide with the Japan Electronics Show, has been structured to provide attendees with a statistical overview of the Japanese electronics industry, as well as a preview of upcoming technological trends.

The seminar is intended both as an introduction to Japan for first-time visitors as well as an update of Japanese business and technology for seasoned travelers in the Far East.

DATE:
October 7, 1987
In conjunction with the Japan Electronics Show

LOCATION:
Royal Hotel, Osaka, Japan

SEMINAR FEE:
$350

OFFICIAL LANGUAGE:
English

CO-SPONSORS:
AEA and Electronic Business

in cooperation with:
RAI Gebouw bv of Holland
U.S. Electronics Industry Japan Office
Japan Electronics Show Assoc.
Osaka Chamber of Commerce and Industry
EDN magazine
Elektronica of Holland
Plesman Publications of Canada

	Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
Thomas Group 2001 Gateway Place, Suite 200W, San Jose, Calif. 94022 Thomas J. Popek: (408) 280-5115	NA	NA	NA	4	2
Trinity Ventures Ltd. 20813 Stevens Creek Boulevard, Suite 101, Cupertino, Calif. 95014 Jerry Casilli, Noel Fenton, David Nierenberg: (408) 446-9690	$8.3	$7.6	$4.5	9	7
U.S. Venture Partners 2180 Sand Hill Road, Suite 300, Menlo Park, Calif. 94025 Bruce J. Boehm, William K. Bowes Jr., Nancy Glaser, Steven Krausz, Roderick C.M. Hall, H. Joseph Horowitz, Jane H. Martin, Stuart G. Moldaw, Robert Sackman, Philip S. Schlein: (415) 854-9080	$171	$42.1	$20.5	44	24
Vast Company Inc. 500 Archdale Drive, Charlotte, N.C. 28210 Peter F. Lai: (704) 527-1537					
Vencon Management 301 West 53rd Street, New York, N.Y. 10019 Irvin Barash: (212) 581-8787					
Ventana 19600 Fairchild, Suite 150, Irvine, Calif. 92715 Stan Fleming, Thomas O. Gephart: (714) 476-2204					

	Total 1986 portfolio ($ millions)	Total 1986 investments ($ millions)	Total 1986 investments in electronics companies ($ millions)	Total 1986 number of deals	Total 1986 number of deals in electronics companies
Venture Funding Group Ltd. 49 West 12th Street, Executive Suite, New York, N.Y. 10011 Allan E. Skora: (212) 691-9895	NA	$10.5	$4.8	14	5
The Vista Group 36 Grove Street, New Canaan, Conn. 06840 Mary Lou Mitzovich: (203) 972-3400	$225	$13	$7.5	22	7
Wachtel & Company Inc. 1101 14th Street N.W., Washington, D.C. 20005 John D. Sanders: (202) 898-1144	$2	$2	$1.2	11	4
Warburg Pincus Ventures 466 Lexington Avenue, New York, N.Y. 10017 Nissan Boury: (212) 878-0671	$1,600	$93.8	$12	27	11
Yamaichi Uni-Ven 333 South Hope Street, Los Angeles, Calif. 90071 Ken Kawabe: (213) 626-0401					
Xerox Venture Capital 800 Long Ridge Road, Stamford, Conn. 06904 L.J. Harris: (203) 968-3383	NA	$6.5	NA	7	NA
Zero Stage Capital Company Inc. One Broadway, 10th floor, Cambridge, Mass. 02142 Gordon B. Baty, David Dominik, Neil R. Henry, Paul M. Kelley: (617) 876-5355	$35	$1.8	$1	6	4

SPEAKERS:

Kaoro Kubo, v.p. and general manager of NTT International
Kazuhiko Kobayashi, manager of the Systems Engineering Division of Hitachi
Hiroshi Komiya, head, Saijou Works, Mitsubishi Electric
Bill Totten, pres. of Ashisuto KK
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Corporate AI R&D accelerates in Japan

There are now an estimated 1,000 artificial intelligence products under development in Japan, mostly at large firms

Artificial intelligence research is continuing at a feverish pace in Japan, despite the country's economic slowdown. Today there are an estimated 1,000 AI products under development in Japan for in-house use at about 100 companies.

And there are no signs that AI fever, which first struck the country in 1984, shows any signs of abating. All of the major corporations in Japan are either importing "shells," the software framework around which expert systems are written, or buying domestically made shells.

By 1990, the Japanese market for AI software — including commercial software as well as software developed for in-house systems — is expected to reach ¥960 billion, or $6.4 billion ($1=¥150); and by 1995, the market will soar to ¥4,785 billion, or $31.9 billion — using the same currency conversion rate. This represents an annual average growth rate of 37.8%. The market for AI hardware, on the other hand — including all forms of computer architecture, both traditional and nontraditional — will grow to ¥247.2 billion, or $1.648 billion by 1990; by 1995, the hardware market will reach ¥894.6 billion, or $5.964 billion. The estimates, which presuppose that Japan's gross national product (GNP) will grow 3.5% annually, were made by the AI Subcommittee of the AI Vision Committee of the Institute of New Generation Computer Technology (ICOT). ICOT is an organization, supported by the Ministry of International Trade and Industry (MITI), to promote the development of Fifth-Generation computers. And the subcommittee, which drew up these forecasts, consists of representatives of leading computer manufacturers, large-scale computer users, and a number of scholars.

Nevertheless, for the moment, AI commercial activity is still very limited. To date, in Japan, there are only about 10 software shells on the market. That compares with about 100 shells currently available in the United States for use in customizing expert systems for specific end-user applications.

The really big AI activity now occuring in Japan is taking place in the research labs of large electronics companies

The relatively smaller number of Japanese-made shells may be a factor in why Japan still lags the United States in commercially available expert systems. While the American AI community is attempting to produce numerous expert systems — for use in medical diagnosis, oil field exploration and military weapons systems — there is only one commercialized expert system currently on the market in Japan. The vendor is Nihon Shakai Iryou Kenkyusho (English translation: Japan Medical Laboratory); and the product is "Zhang Zhong Qing," an expert system which recommends herbs and other traditional Chinese medicines based on a description of the patient's symptoms fed into the system by a medical technician. Since its introduction last November, Nihon has sold 15 of the software packages, which run on an NEC Corp. business microcomputer. In addition, Kaou, a soap company, has shipped several experimental expert systems to Japanese department stores to advise salespersons on which cosmetic products to recommend, depending on the characteristics of the customer's skin.

AI in Japan: Vital statistics

Number of firms investing in AI	100 (estimate)
Number of expert systems	1,000
Number of commercial shells	10
Number of commercial expert systems	1
Number of Japanese firms selling AI machines developed in house	3*

* Fujitsu, Mitsubishi and NTT

Source: ELECTRONIC BUSINESS

Lab work

If one includes the sales of shells, machine translation systems, higher language software products used in AI research, or proprietary expert systems developed by large firms in conjunction with users, then the Japanese AI market is much larger. Nihon Univac Kaisha, for example, has sold about 10 shell copies of KEE software from Intellicorp of Menlo Park, Calif. The shells run on NUK's KS301 Lisp machine. And Digital Equipment Corp. Japan has delivered about 100 OPS.5 shells; 150 systems offering VAX Lisp, a very popular AI language; not to mention reselling assorted AI software products from Teknowledge Inc. and AI Technologies Corp.

The really big AI activity now occurring in Japan, however, is taking place in the research labs at large multinational electronics companies. "We have 75 AI projects [going on] in the Computer Division alone," one Fujitsu Ltd. insider, who asked not to be identified, recently told ELECTRONIC BUSINESS. And a manager in the Computer Division at Hitachi Ltd. claims his company now has 120 AI projects on the books.

Bit by bit, though, many of these products are beginning to see the light of day. The following is a synopsis of AI and AI-related products now available from some of Japan's largest computer houses:

- **Fujitsu.** The company has delivered 130 mainframe shells, 30 microcomputer shells and an undisclosed number of ESHELL-SB superminicomputer shells used in real-time processing for manufacturing applications. Introduced last October, the ESHELL-SB can be used to develop expert systems using raw data directly acquired from instruments and other measuring devices on the factory floor. It has also sold 50 units of Facom Alpha which it claims is the world's fastest Lisp machine; and 190 of its Atlas Model I and Model II machine translation systems.

- **Hitachi.** In addition to its Motorola 68020-based Creative Workstation 2050, which it claims has potential AI-related office automation applications, Hitachi also offers a Hitac E-7300 workstation for the AI engineering environment. Altogether, it has sold about 100 model ES-Kernal shells for the 2050 workstation. Hitachi also says it has sold 30 machine translation systems to universities, banks, laboratories and other large institutions.
- **IBM Japan.** The company now offers four AI languages for its mainframes. In cooperation with Carnegie Mellon University, it is also developing a two-way Japanese-English translation system due in 1989.
- **Mitsubishi Electric Corp.** Based partly on a prototype of the Personal Sequential Inference machine developed for ICOT and Japan's Fifth Generation Computer Project, Mitsubishi has delivered 30 shells which run on its own $133,000 Prolog-language machine. The company is also developing a machine translation system.
- **NEC.** The company has delivered 20 shells for its ACOS mainframe series and five multilingual machine translation systems which can translate documents from English to Japanese and Japanese to English. It has also delivered a knowledge-based fingerprint recognition system to about 20 police departments around the world.
- **Toshiba Corp.** Along with an AI shell for its Unix supermini series, Toshiba also offers a microcomputer-based shell. In addition, the company has shipped 10 machine translation systems.

Other Japanese companies with AI products on the market include Mitsubishi Research Institute; Toyou Information System (which offers packages which run on Symbolics Corp. AI processors); Nippon Telephone & Telegraph (which sells NTT-developed AI software products through DEC Japan and has just announced its own Lisp workstation); and Bravice International, the pioneer in the machine translation system market. Bravice has sold 2,200 Japanese-to-English software packages which run on NEC and IBM desktop machines. And the independent software house also offers systems for English-to-French translation, English-to-German and English-to-Spanish.

SHOHEI KURITA

CALENDAR

UNITED STATES

May 18. **Opportunities in Flat-Panel Displays.** Ritz-Carlton Hotel, Boston. Arthur D. Little Inc. (617) 864-5770

May 18-21. **SEMICON/West.** San Mateo Fairgrounds, San Mateo, Calif. Semiconductor Equipment and Materials Institute (SEMI). (415) 964-5111

May 27-29. **AEA Financial Conference for Emerging Growth Companies.** Hyatt Regency Hotel, Monterey, Calif. American Electronics Association (AEA). (415) 857-9300

May 30 - June 2. **Summer Consumer Electronics Show.** McCormick Place, Chicago. Electronic Industries Association/Consumer Electronic Group (EIA). (202) 457-8700

June 1-4. **COMDEX Spring.** Georgia World Congress Center, Atlanta. The Interface Group. (617) 449-6600

CEG June 9-11. **NEPCON East '87.** Bayside Exposition Center and World Trade Center, Boston. Cahners Exposition Group. (312) 299-9311

June 9-11. **VISION '87.** Applied machine vision conference & exposition. Cobo Hall, Detroit. Machine Vision Association of SME (MVA/SME), Automated Vision Association (AVA). (313) 271-1500

June 15-18. **NCC '87.** National Computer Conference. McCormick Place, Chicago. American Federation of Information Processing Societies, Association for Computing Machinery, Data Processing Management Association, Institute for Electrical and Electronics Engineers (IEEE) Computer Society and Society for Computer Simulation. (703) 620-8970

CEG June 16-18. **ISC Expo 87.** International Security Conference and Exposition. O'Hare Exposition Center, Rosemont, Ill. Cahners Exposition Group. (312) 299-9311

June 22-25. **ATE East.** World Trade Center, Boston. Morgan-Grampian Expositions Group. (800) 223-7126

June 28-July 1. **Design Automation Conference.** Miami Beach Convention Center, Miami Beach, Fla. IEEE and ACM. (303) 530-4562

July 27-31. **Siggraph '87.** The 14th annual conference on computer graphics and interactive techniques. Anaheim Convention Center, Anaheim, Calif. Siggraph '87 Conference Management. (312) 644-6610

CEG Aug. 24-26. **ISC Expo East 87.** International Security Conference and Exposition. Jacob Javits Convention Center, New York City. Cahners Exposition Group. (312) 299-9311

Sept. 1-3. **International Test Conference 1987.** Sheraton Washington Hotel, Washington, D.C. IEEE Computer Society, IEEE Philadelphia Section. (201) 895-5260

Sept. 9-11. **Seminar on Modern Electronic Packaging.** Marriott Sea-Tac Hotel, Seattle. Technology Seminars. (301) 269-4102

Sept. 15-17. **Midcon.** O'Hare Exposition Center, Chicago. Electronics Conventions Management. (213) 772-2965

Sept. 22-24. **SEMICON/East.** Bayside Exposition Center, Boston. Semiconductor Equipment and Materials Institute (SEMI). (415) 964-5111

Sept. 22-24. **Northcon.** Portland Memorial Coliseum. Portland, Ore. Electronic Conventions Management. (213) 772-2965.

CEG Sept. 26-28. **CEPS VI.** Corporate Electronics Publishing Systems. World Trade Center, Boston. Cahners Exposition Group. (203) 964-8287

CEG Sept. 29-Oct. 2. **INFO/Information Management Exposition and Conference.** Jacob Javits Convention Center, New York City. Cahners Exposition Group. (203) 964-0000

Oct. 5-9. **EIA Fall Conference.** Century Plaza Hotel, Los Angeles. Electronic Industries Association (EIA). (202) 457-4900

Oct. 14-15. **SEMICON/Southwest.** Infomart, Dallas. Semiconductor Equipment and Materials Institute (SEMI). (415) 964-5111

Oct. 19-21. **Connectors and Interconnection Technology Symposium.** Franklin Plaza Hotel, Philadelphia. Electronic Connector Study Group. (215) 825-3840

Oct. 25-30. **AEA Monterey Financial Conference.** Hyatt Regency Hotel, Monterey, Calif. American Electronics Association (AEA). (415) 857-9300 ▷

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Graphics terminals: Strategies for future growth

Semiconductor production: Mini-fabs reshape the market

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$ Most profitable electronics companies $

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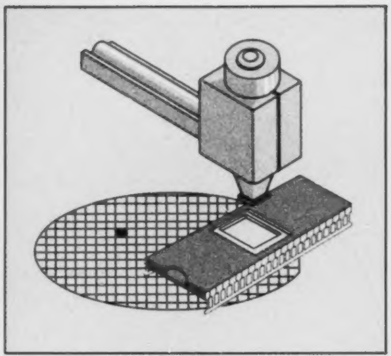

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HP and ASK Computer provide a Florida power supply firm with a host of manufacturing solutions.

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VBPA ABP

Like IBM's new PCs, the future is ASICs

As computers demand ASICs, the trade tiff increases DRAM prices. More dollars for semis

"We've surrounded Intel's [microprocessors] with IBM's custom logic," said William Lowe, president of IBM's Entry Systems Division, last April when he introduced Personal System/2, the company's new generation of personal computers. Taking the covers off some of the new machines, Lowe's people expose a motherboard showing neatly arranged rows of standard looking memory chips and three or four very big ICs. The memory chips may look standard but aren't — they are 1 Mb DRAMs that IBM makes in Essex Junction, Vt. As for the large ICs, all packaged in pin-grid arrays of 42 leads and up, they also bear IBM markings. One of them is an Intel microprocessor (8086, 80286, or the new 80386, depending on the computer model), the others are custom CMOS logic chips that IBM makes in Essex Junction and in East Fishkill, N.Y. By coalescing so much logic into custom chips, IBM has not only saved money on ICs and real estate on its printed circuits, but has made it more difficult for would-be competitors to clone the new computers.

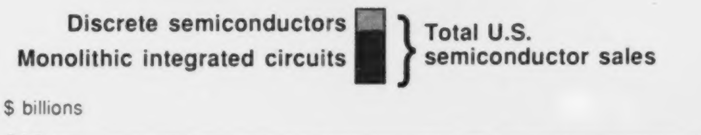
If, as IBM hopes, the machines sell, it will keep not only its captive semiconductor fabrication busy but also the merchant makers of application specific ICs, especially in CMOS. Not surprisingly, two of the Personal System/2 machines delivered only one week after their introduction went to ZyMOS. Daewoo, the Korean company that makes the Leading Edge "D" clone of IBM's PC AT, owns 56% of this Sunnyvale, Calif., manufacturer of ASICs. ZyMOS has no orders yet from its Korean parent, says marketing vice president Dave Guzeman, but knows that Daewoo as well as other clone manufacturers must duplicate IBM's move into ASICs to stay competitive. Presumably, most of these competitors will try to clone at least the new version of the PC, IBM's model 30. Zenith Electronics, for one, already uses ZyMOS' ASICs for its AT clone.

CMOS and bipolar ASIC sales to manufacturers of computers of all sizes are providing welcome relief for semiconductor makers. "Cray, DEC, and Tandy use Motorola's bipolar gate arrays," Charles Thompson, worldwide marketing director of Motorola Semiconductor Products, says with no small pride.

The Semiconductor Industry Association reports that total semiconductor shipments to the U.S. market increased by 5.2% (in dollars) in 1986, and gained strength in the first quarter of this year. Analyzing these figures, market researcher Jack Beedle of In-Stat provides a very perceptive view of where this growth took place in 1986. Most of it was in discrete semiconductors, which increased shipments by almost 7%. ICs grew only by 4.8%. Not surprisingly, the IC growth star in the United States was CMOS, 40.6% (many of them from ASICs shipments), followed by analog ICs with 18%. MOS logic (other than CMOS), dropped 6.9% and, as expected, MOS memory fell 18.3% in dollars, mostly because their prices were off almost 10% with respect to 1985's. However, prices of 64K and 256K DRAMs firmed up considerably in the first quarter of this year, as a reaction to the U.S. government's sanctions against Japan, and in response to that country's announced intention to curtail DRAM production. If these price increases stick, the total U.S. semiconductor market could grow even more than the 15% that Cahners Economics forecasts for 1987.

ALBERTO SOCOLOVSKY

U.S. semiconductor sales



Historical data: Semiconductor Industry Association
Forecast: Cahners Economics

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, has been climbing steadily since the summer of 1986. The fourth quarter was up 0.7% from the prior quarter bringing yearly production up 1%. This year, modest gains are expected to continue through midyear with sharper increases in industrial production expected in the third and fourth quarters.

The Cahners Early Warning Indicator (CEWI) is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index. It forecasts probable business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 104.1 level forecasts using the CEWI for the end of this year indicates that the average for all of 1987 should be 4.1% above 1986.

Readers can obtain a brochure explaining the CEWI method from Cheryl Patstone, economist, Cahners Economics Department, 3021 Tisch Way, Suite 100, San Jose, Calif. 95128.

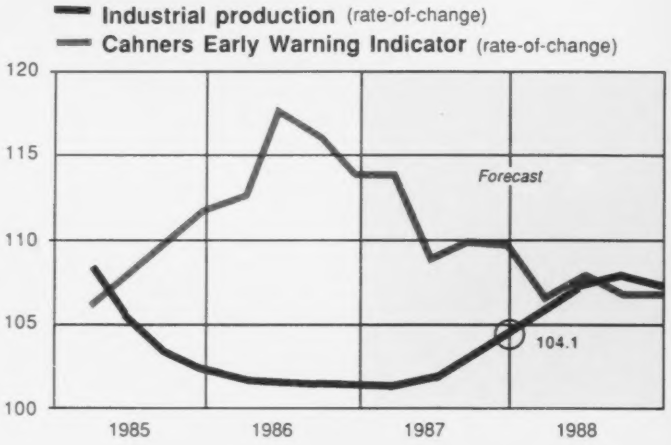
Defense and space equipment

Reductions in military spending authority in fiscal 1986 and 1987 have begun to take the steam out of the defense boom. Many programs have been stretched out, causing growth in military-equipment production to slow to a modest 4% to 5% year-to-year rate down from a 10% rate just 12 to 15 months ago. The budget will continue to be squeezed in fiscal 1988 and beyond as Congress fights to reduce the federal deficit, bringing a further moderation in defense market growth. Production, which showed an unexpectedly strong 2.4% gain in last year's fourth quarter, grew an estimated 5.6% in real terms for all of 1986. The pace of growth is expected to slow to just 4.8% this year and 1.6% next year.

Aircraft and parts

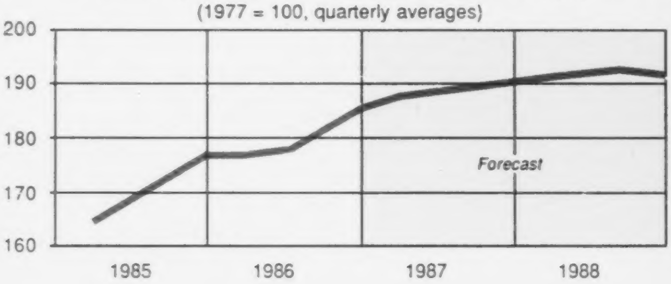
Aircraft production increased 2.5% in last year's fourth quarter compared with the third quarter and posted a gain of 12.3% (in real terms) for all of 1986. This was the industry's strongest growth performance in seven years. Most of the increase was attributable to expansion in the military aircraft market, which is being boosted by carryover spending from past defense budgets. Recent budgetary actions are likely to dampen growth in this segment of the industry over the next several years. Despite a comeback in the nondefense market, overall production of aircraft and parts is expected to post a moderate 6.1% gain this year and then to dip approximately 0.7% next year.

Economic indicators



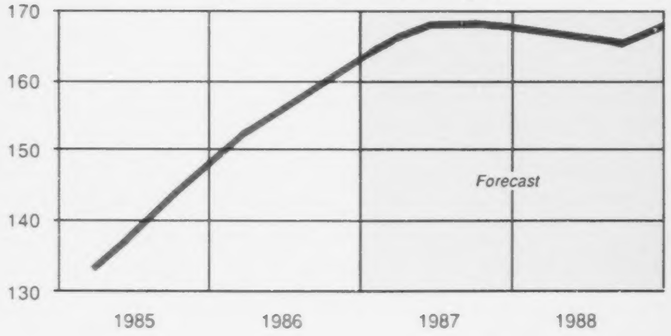
Industrial production: Defense and space equipment

(1977 = 100, quarterly averages)



Industrial production: Aircraft and parts

(1977 = 100, quarterly averages)



Historical data: Federal Reserve Board
Forecast: Cahners Economics

Seoul sourcing: Nationals demur as regionals jump in

Korea's chip makers want stronger U.S. distribution networks. But they're not getting it from the big boys

Describing the U.S. sales success of Korean chip makers is a bit like the old attitude test. Is the glass half full? Sure: they have won stellar sales in two short years. Or half empty? They have yet to secure a major original equipment manufacturer (OEM) order or a national distribution franchise.

Selling about $60 million worth, or 0.6% of all semiconductors bought in the United States last year, hardly qualifies the Koreans for the big time. Neither does their strength in memory product, where they captured under 2%, keep Motorola Inc. salesmen awake nights.

But they only began selling in 1985. This year, U.S. sales of the Califonia-based Big Three — Goldstar Semiconductor Ltd. in Sunnyvale, Hyundai Electronics America and Samsung Semiconductor Inc., both in Santa Clara — should reach $185 million, or 1.6% of total, while their memory chips could run off with a 4% share.

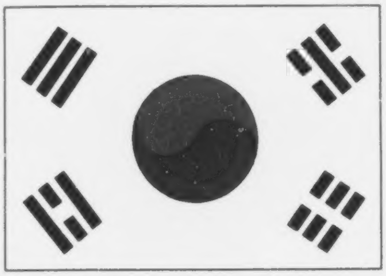
Distribution is pivotal to further gains. While credibility will soar if Seoul-sourced chips are designed into a big OEM's new product, good distributors will open a broad customer base. That is why these three, like the Japanese seven years ago, have lost no time in forging what distributor liaisons they can. Samsung sells through 40 local industrials nationwide. Hyundai has about 25. Even low-profile Goldstar can lay claim to 10. (Daewoo, the fourth member of Korea's *chaebol*, or industrial-conglomerates club, acquired custom-chip maker Zymos Inc. last fall but sells no Korean-made product through distribution.)

These small local and regional middlemen did the Koreans proud: last year they provided about 30% of their vendors' aggregate U.S. sales. "Well above plan," smiles Samsung distribution director Clyde Brewer. Order sizes remain small: typical for local distributors are the $15,000 to $25,000 deals. But they are gaining momentum: Santa Clara-based Cypress Electronics, a $34 million Western regional with seven stocking locations, recently clinched an $800,000 contract for memory chips from a computer-peripherals maker.

Pricing tactics

The Koreans' early inroads are due in part to their pricing, which often, but not always, comes in 5% to 10% lower than competitive product. And partly it's due to availability as other chip sources have atrophied. It also doesn't hurt that Goldstar TVs and Hyundai cars are proving popular.

But throughout, Japan's difficulty has been Korea's opportunity: with Hitachi et al. under fire from U.S. chip makers and lawmakers alike, increased fair market value prices, as determined by last year's U.S./Japan chip accord, are forcing Japanese chips off the shelves and out of the market.



This year, U.S. sales of the Big Three — Goldstar Semiconductor Ltd., Hyundai Electronics America and Samsung Semiconductor Inc.—should reach $185 million

So far, two-thirds of the Koreans' offerings have been memory product: 64K, and increasingly, 256K dynamic random-access memory (DRAM) chips. The biggest and boldest contender, Samsung, is about to begin selling a 1-megabit (Mb) DRAM. About 70% of its distributor sales come from memory devices, but the goal is to get half from other products, like its transistors, some linear circuits, logic chips and electrically erasable read-only memory (EEPROMs), and from new lines, like power metal-oxide semiconductor field-effect transistors (MOSFETs) and standard EPROMs.

Hyundai, which observers say trails the aggressive Samsung by about a year, is still ramping up its 256K DRAMs while preparing a 1Mb DRAM. Goldstar, further behind still, is marketing only logic chips.

However, to claim that the Koreans have cracked U.S. distribution markets would be like saying Hyundai's subcompact car rips through the quarter-mile in 10 seconds. The full franchises with top-tier houses — the ones that would signal that the Koreans had really arrived — remain elusive. "We believe we need a couple of strong national distributors. We're doing everything to get them and having a hard time at it," admits Brewer.

It's not hard to see why. The big industrials fear reprisals from their U.S. chip suppliers — and even from Japanese vendors. Talk to Howard Franklin, president of Bell Industries Inc.'s Electronics Marketing Group, and others. The answer is the same: they are not about to lose existing chip franchises.

And for what? Several top-line distributors contend that the Korean product's quality is far from proven, a charge the Korean vendors — and their local distributors — quickly refute. Others are not tempted by limited product: memory chips do not a full range make. Some simply say that full pipelines from existing suppliers make other brands redundant.

Marshall Industries marketing vice president George Tarnawsky offers another perspective: he figures that distributors will get burned if the federal government turns today's Japan-bashing binge into attacks on Korean product pricing. "So why jump into something if that something is going to be short term?" he asks.

Interestingly, that didn't stop industry leader Hamilton/Avnet, a division of Avnet Inc., from inking a "purchasing agreement" with Samsung last fall. Caught with acute shortages of 256K DRAMs from domestic suppliers like Motorola, Hamilton/Avnet opted to buy Samsung 256K DRAMs on a selective basis.

Samsung is delighted with the link-up. Says distribution manager Brewer: "It has done a very nice job for us." Hamilton/Avnet refused to return repeated phone calls about the dalliance which several competitors view as a thinly disguised franchise, not the simple purchasing agreement Hamilton/Avnet insists it is. "If it walks like a duck and quacks like a duck, then it's at least a drake," quips Stephen Kaufman, president of Arrow Electronics Inc. "I guess what they're trying to do is become half pregnant," adds Marshall's Tarnawsky.

The reaction of small regionals that carry Samsung is less predictable. Far from feeling abused, many praise the pact for raising the profile of the Korean lines. "We're happy to see it happen. It gives the line a lot of validity," says Arthur Nyblin, founder of QPS Electronics Inc., a new distributor serving Chicago and expecting nearly a third of its $3.5 million in sales to come from Korean chips.

But what major national franchises will not do is give the Koreans 100% share of mind. Which is why Samsung's Brewer, for one, is keen to continue using "Mom and Pop" distributors too.

Indeed, it is clear that there's a whole lot of using going on. The Korean chip makers are clearly using second- and third-tier distributors until they can get big-league industrials to be their front-runners. "Upgrading the quality of our distributors," is how it is billed.

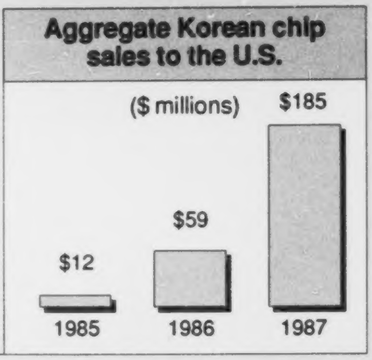
Not that the little guys seem to mind. They're busy exploiting back, many of them using Korean product to diversify out of soggy electromechanical or passive components and into lucrative and sexy semiconductor sales. Admits one: "If I had the opportunity to take a Motorola line, I would give up the Samsungs of this world readily."

There's plenty of education to go with the mutual exploitation. Edward Kramar, president of Cypress Electronics, believes he was lucky to hook up with the Koreans so that he could learn how to handle chips without the pressure that a Japanese franchise might have put on him.

The Koreans have used their new allies to uncover the secrets of distribution. According to several sources, the chip makers of Seoul, like the Japanese before them, were somewhat naive when it came to the nuances of return policies and stock rotation practices. They also took some time to relax credit procedures that were tighter than U.S. distributors were accustomed to. The Korean companies were initially demanding payment

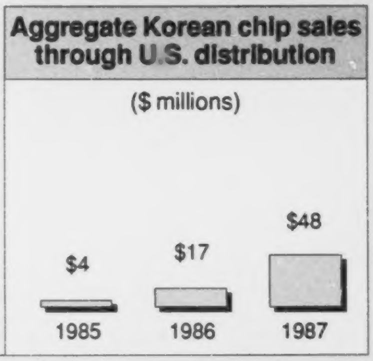
Korean semiconductor sales in the U.S.

Korean chip sales to the U.S. are still tiny. . .



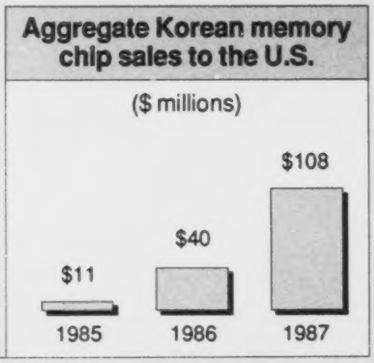
	1985	1986	1987
Percentage of total market	0.12%	0.58%	1.62%

as distributors play their part. . .



	1985	1986	1987
Percentage of total market	0.17%	0.64%	1.56%

but the gains are faster in memory semiconductors



	1985	1986	1987
Percentage of total market	0.51%	1.96%	4.37%

Source: Dataquest Inc.; industry and ELECTRONIC BUSINESS estimates from distributors in 10 days — "pretty much impossible to do," says William Cassel, marketing vice president of Schuster Electronics Inc. in Cincinnati — and shutting off supplies promptly after 30 days if still not paid.

But they have learned fast. One of the key lessons cited by Jae Y. Park, Hyundai's national sales manager, is that America is unique in terms of serving the customer. "It's not the sales channel which tells us what to do — it's really the customer," he says. Park also notes the need not merely for availability of good product, but for good ongoing relationships with distributors.

Samsung learned early to use experienced American marketing managers, a talent that has clearly stood it in good stead. And it has adeptly tapped the gray market, selling 10% to 20% of its non-OEM chips through nonfranchised brokers at discount prices.

Many small franchised distributors, paying more and charging more for Korean product in return for full price protection and other franchising advantages, criticize this practice. "A traitorous, petty measure" says one. Samsung's Brewer, however, defends the approach: "Those guys [the brokers] were the only guys that had a great interest in us at the very beginning. And they really know the memory business," he says.

> Korean electronics companies would prefer to be seen as trading partners, not as rapacious raiders

In gray markets, Samsung's 256K DRAMs with 150 nanosecond speeds sell for as little as $1.63 in 10,000-part buys. Less than their Japanese equivalents? "Oh, God — incredibly less! We'd be lucky to get [the Japanese chips] down to $1.90," exclaims a saleswoman at broker CAL-ABCO Inc. At another broker, Centon Electronics Inc. in Irvine, Calif., the same chips come in 20 cents cheaper than Japanese equivalents.

Marginal existence

While the brokers may be happy to make skin-thin gross margins, the franchised distributors want at least 25%. And they are getting it. Margins are acceptable: QPS in Elk Grove Village, Ill., for instance, makes up to 35% on its Korean semiconductors.

Pricing is not quite the issue many think it is. The Koreans are not anxious to attract any of the government spotlight they so fortuitously take advantage of right now. "We're trying desperately to maintain prices. We're trying to stay out of the eye of the federal government, so we're staying very clean. We're very sensitive to that issue," says Samsung's Brewer.

For all their rapid progress, the Koreans have been noticeably cautious in approaching the U.S. market. "They turned out not to be the aggressive giant-slayers we had hoped for," says Cypress chief Kramar. Put that down to their not realizing how strong the Japanese hold on the market was, and how much long-term commitment distributors have to vendor relationships.

There is also a desire not to goof up. "In the U.S. market, first impressions are very important. Before starting, we need some experience in quality," says Goldstar sales manager H.S. Yoon, pointing out that his chips are being tested exhaustively in the Far East before being released for sale here.

While plenty depends on the outcome of the Japanese trade restraints, the consensus appears to be that Korean chip makers are here to stay. "I think they're a force to be reckoned with. They bring more to the party than low prices: they bring quality and financial strength," says Tony Cucchi, president of Philadelphia-based multiregional distributor Almo Electronics Inc., where pricing problems with Japanese DRAMs and EPROMs have slashed growth plans and sparked interest in the Korean chips.

The Koreans themselves are keen to be seen having strong commitment to distribution channels, and to appear as strong second sources of commodity product. On the broadest level, they would prefer to be seen as trading partners, not as rapacious raiders: Hyundai cars already use U.S.-made glass, tires and carpets; the Seoul government also plans to import U.S. fossil fuels to redress its trade balance.

Therefore, conclude some semiconductor market researchers, national distributors would do well not to ignore the Koreans. Quoting Marshall as an example of a top-ranking distributor that rose from the second level on the back of aggressive marketing of Japanese chips, one observer hints that the reverse could happen to the big boys if they do not respond to market forces.

JOHN KERR

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Top-to-bottom changes in graphics terminals

The graphics terminal industry is undergoing some fundamental changes at both the high and low ends

By David Card

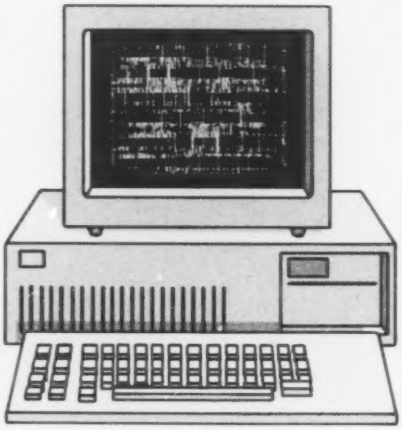
It is a familiar story. Yet another electronics market restructures as the cost of computing power shrinks. This time it is graphics terminals, where personal computers (PCs) are infringing on the low end and 32-bit graphics workstations move in at the top.

There is no future for "dumb" terminals — those with no local processing power — says Carl Machover, president of graphics market-watcher Machover Associates Corp. in White Plains, N.Y. Even IBM terminals are being overtaken by PCs, he says. However, Machover says that it is premature to say that a graphics workstation is the only way to go at the high end. Likewise, Dataquest Inc. analyst Michael Tyler out of San Jose, Calif., says, "the jury's still out" on the issue of standalone computers versus terminals in many graphics applications.

The price advantage that terminals enjoy over computers and the ease of controlling a company database on a large host are two factors favoring the survival of graphics terminals, Tyler says. But, he forecasts that next year unit sales of PC graphics boards that compete with low-end terminals will outstrip terminal sales for the first time.

At the low end, terminal leader Tektronix Inc. finally got tired of start-ups writing software for PCs to emulate Tek's industry-standard terminals. So, in March, Tek signed up one of those start-ups, Grafpoint, to write the software for a Tek package that includes a Tek-built add-in board and a monitor from Sony Corp. Just months before, Tek also introduced a new line of graphics terminals with price tags as low as $3,000, a 40% to 65% price cut over comparable models. According to Jon Reed, vice president and general manager of Tek's Information Display Group in Wilsonville, Ore., Tek only went into PC graphics to keep its current customers. Many of them were buying PCs by the truckload.

Among noncomputer companies, Dataquest ranks Tek as the leading independent graphics terminal producer. Tek has always aimed its terminals first at Digital Equipment Corp. computers, and DEC does resell some Tek terminals. So it was a blow when DEC's workstation, the VAXstation series, came out last year with DEC terminals sitting on top of them. Reed says that this is nothing new — DEC's hosted graphics line, including its VT200 and 400 terminals, always competed with Tek's. "The upper end is where it's changing," Reed admits.



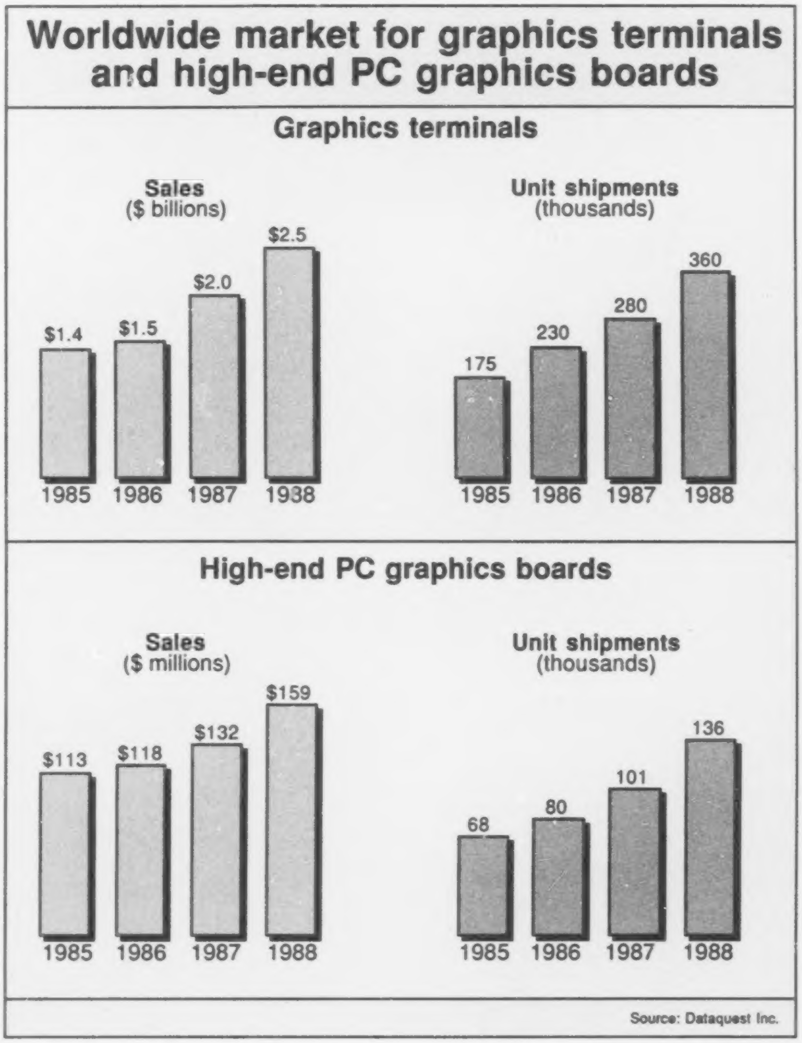
"IBM is the only place terminal makers have a future because DEC *will* be a workstation company"

Gary Meredith of Evans & Sutherland

And changing it is. "A lot of people won't talk to you without a workstation," says Gary Meredith, president of the Interactive Graphics Division of Evans & Sutherland Computer Corp. in Salt Lake City. Meredith claims that McDonnell Douglas Corp.'s fighter plane unit is his biggest customer, buying some 300 to 400 three-dimensional terminals a year. Yet other McDonnell divisions buy graphics workstations from Silicon Graphics Inc. (SGI) of Mountain View, Calif. Silicon Graphics president Edward McCracken also calls McDonnell his largest customer. So Evans & Sutherland signed an agreement with DEC to team up on an ultra high-end graphics workstation.

Meredith claims that between DEC doing its own midrange graphics and the joint effort on the high-end workstation, the DEC market has dried up. "IBM is the only place terminal makers have a future because DEC *will* be a workstation company," Meredith says. Until the new model comes out later this year, there is nothing to preclude people buying a $20,000 VAXstation and sitting a $47,000 Evans & Sutherland terminal on top, he adds. Meredith says that his division had nearly $50 million in sales last year.

Tektronix's Reed says that Tek has always shunned the upper end of the market, preferring to stay away from $50,000 terminals. Tek got into the graphics business in the early '70s, and Reed credits his installed base and de facto standard software routines for Tek's staying power. A newer realm is the PC add-in board that Reed initially expects to sell into that


Worldwide market for graphics terminals and high-end PC graphics boards

Source: Dataquest Inc.

base. But other Tek marketing managers estimate that Tek will have to generate as much as 85% of its board sales through channels other than its direct salesforce.

Niche strategies

Most graphics terminal companies do not have the luxury of the Tektronix lineup, which includes intelligent terminals incorporting 16-bit chips from Intel Corp. and 32-bit workstations as well. Tek also does a quarter of its estimated $400 million graphics business in digitizers and color printers. Most companies are developing niche strategies.

But Seiko Instruments U.S.A. Inc. is not most companies. The U.S. subsidiary of the Japanese company, which owns as much as 70% of the Japanese graphics market, is going all out, Dataquest says. "Everyone is saying the world is heading to the point where everybody is going into niche markets because they can't compete," says Andrew Wei, division manager of the Graphic Devices and Systems division in San Jose. "We believe differently." Seiko U.S.A.'s sales mix is the reverse of Tek's, with 70% to 80% of its sales coming from printers and other peripherals. But Wei wants to make it 50-50 for terminals, and he comes close to admitting that he is willing to buy market share. "You can't look too long at a quarterly profit to get there," Wei says.

But the two analysts say that Seiko has yet to be successful in the United States. Wei admits Seiko is "still in the process of getting the user to rewrite his software" to support Seiko graphics. Seiko has so far stayed pretty much in the middle performance range, and Wei is not aiming at the high end, yet. He believes more money can be made selling terminals and add-in boards to the next generation of PCs. But, he says: "The next big question over the next three years" will be whether Seiko puts a central processor-type chip into its terminals.

"There are those who say the days of the host-dependent terminal are dead. Well, that's not true. There are an awful lot of MicroVAXes being sold," says Joseph Morris, vice president for marketing for Ramtek Corp. in Santa Clara, Calif. Morris attaches three or four terminals to a 32-bit MicroVAX from DEC and dares workstation makers to compete on a cost-per-seat basis.

Ramtek also has two distinct tracks for its terminals — graphics and imaging. Ramtek sells into applications such as satellite mapping where images are based on real life rather than completely computer generated. Tyler of Dataquest says that Ramtek is particularly adept at combining graphics with images, especially, for example, in a weather map where the topographical map overlays a satellite photo.

A focused approach

One advantage of the focused approach is an easily identified customer base. "I don't have to go out and count smokestacks," Morris says, "You can tell who the customers are." Aerospace and petroleum companies, and government agencies such as the National Aeronautics and Space Administration (NASA) are customers.

Ramtek, however, is only just starting to see the benefits of its focus. The company has been losing money for two years — $2.1 million on sales of $39 million in fiscal 1985 (ending

June 30); $15.3 million in losses the previous year. Last July, Ramtek sold off a subsidiary that was trying to get into the movie animation business. Ramtek has since turned profitable again.

United Telecommunications Inc. subsidiary Megatek Corp. of San Diego does not release sales figures, but analyst Machover estimates Megatek sold some $40 million worth of its high-end terminals. Megatek Graphics Systems vice president Patrick O'Brien characterizes the graphics business of the last three or four years as one plagued with turmoil. "We have stayed alive because of our high-end focus," he says. "And it never hurts to have a strong parent."

O'Brien continues: "The burning question is: Why do we think we will be successful [against] the emerging market for workstations?" Megatek's answer is to keep up at the high end — moving 3-D, shaded solids — and bet on the cost per seat and database arguments. O'Brien says that a workstation is not in his immediate plans, unless one of his large customers like Hughes Aircraft Co., Ford Motor Co.'s Aerospace division or Northrop Corp. demands it. Even so, Megatek already incorporates Intel's 32-bit 80386 microprocessor in its intelligent terminals.

O'Brien is also quick to point out "a new characteristic of the emerging Megatek — very aggressively priced products." Megatek's full range runs from $22,000 to $57,000 in price. O'Brien says that he can keep costs down via the latest in new design technology. Megatek was a beta site for Silicon Compilers Inc. (now called Silicon Compiler Systems Corp.), using its computer-aided engineering (CAE) systems that allow systems designers to design custom chips. □

The rise of Silicon Graphics

One company causing major headaches among high-end terminal makers is 6-year-old Silicon Graphics Inc. of Mountain View, Calif. Silicon Graphics had $41.5 million in sales last fiscal year (ended June 30) and $34.7 million the first six months of fiscal 1987, often at the expense of the more traditional graphics companies.

Silicon Graphics designs its own graphics chip set, but relies on other companies for its central processor. Its first workstations, in the $50,000 to $75,000 price range, contain the same Motorola Inc. chips that are the guts of general-purpose workstations from Apollo Computer Inc. and Sun Microsystems Inc. For the new model, SGI went to a reduced instruction set computing (RISC) chip set from start-up MIPS Computer Systems Inc. Silicon Graphics president Edward McCracken says that the founders of SGI, MIPS and Sun all graduated from the same class at Stanford University.

McCracken says that Prime Computer Inc. convinced SGI to forego the next round of Motorola chips and skip directly to MIPS Computer, throwing a little cash both companies' ways to encourage things. Prime now resells the SGI/MIPS machine as its workstation offering.

So will Control Data Corp., which also resells the earlier SGI workstation. SGI's 3-D graphics are the best of the workstation lot, according to E.E. Randoll II, general manager for computer-integrated manufacturing (CIM) marketing at Control Data. CDC needed such performance so that both electrical and mechanical design could be done on the same workstation. SGI's McCracken is hoping to use this to crack the mechanical engineering departments of the other two Big Three auto makers — he already claims General Motors Corp. as a customer. He says that Ford Motor Corp. is a Prime house; and Chrysler Corp., a CDC shop.

Tektronix Inc. vice president Jon Reed says that SGI's workstations are similar to Tek's 4400 line, which only uses 16-bit chips from Intel Corp. "Frankly our machines don't compare," Reed says. Tek has a 32-bit workstation, but Tek's own design automation division opted not to support it, casting doubt on its life span.

Reed cautions that the arrival of companies like MIPS may not be all good news for SGI. The "amazingly cheap MIPS [millions of instructions per second]" that such companies offer make it easy for graphics companies to stay away from the computer business and concentrate on graphics. Reed says that Tek is very interested in the under-$50,000 graphics workstation business and hints that a deal with a major player is cooking. He had better hurry up, McCracken says. Of the big workstation companies, Apollo traditionally does its own high-end graphics, as does Hewlett-Packard Co.; Prime and CDC are taken; Sun has a reference-selling deal with General Electric Co.'s graphics division, and Digital Equipment Corp. is teamed with Evans & Sutherland. □

SGI's PRESIDENT EDWARD McCRACKEN: His company went to a RISC chip set from start-up MIPS Computer Systems for its new model workstation

Mainframes: Lowdown on the slowdown

Power-packed minis and micros have stalled mainframe growth. But there are compatible bright spots beyond Big Blue's hue

By Anne Knowles

Mainframe market growth slowed to single digits last year and will only get worse before it gets better, say industry analysts. In 1986, worldwide mainframe revenue for U.S. vendors rose 3.4%, to $17.55 billion, according to International Data Corp., a market research firm in Framingham, Mass. This year, mainframe sales should be flat, says Frank Gens, an analyst with IDC. And in 1988, predicts Steven Milunovich, an analyst with First Boston in New York City, IBM's mainframe sales — which make up nearly two-thirds of the market — could drop by 10%.

Many analysts believe the days of double digit growth in the mainframe arena are gone forever. Mainframe sales are being sapped for a number of reasons First Boston's Milunovich says there is a shift away from buying large processors to purchasing smaller systems, including low-end mainframes, with smaller price tags, and superminis, which are sold by more vendors in a more competitive marketplace. While mainframe sales remain stagnant this year, sales of personal computers and minicomputers should rise about 10%, says IDC's Gens. "Minis are acting as a siphon on new mainframe demand," says Gens.

The mainframe market is suffering from lack of adequate software

The siphoning action is distributing processing power across a number of systems rather than centralizing it on mainframes. Since the advent of 32-bit desktop computers, with more raw processing power or millions of instructions per second (MIPS), end users can fulfill computing requirements with smaller, less expensive systems that have better price/performance ratios than their larger brethren. Across IBM's product line, for example, the cost per MIPS increases as the number of MIPS on a system increases, says Kimball Brown, an analyst with Dataquest Inc., a market research firm in San Jose, Calif. Customers are opting to buy smaller machines that provide more bang for the buck.

In addition, the mainframe market is suffering from lack of adequate software. "The slowdown has been caused by [a lack of available software] applications to utilize existing products," says Fred Meier, vice president for corporate management at Unisys Corp. Most analysts agree. "The software tools to develop applications haven't advanced as quickly as hardware technology," says IDC's Gens. "Until there are major technological improvements in tools it's not likely we'll see a return to high growth."

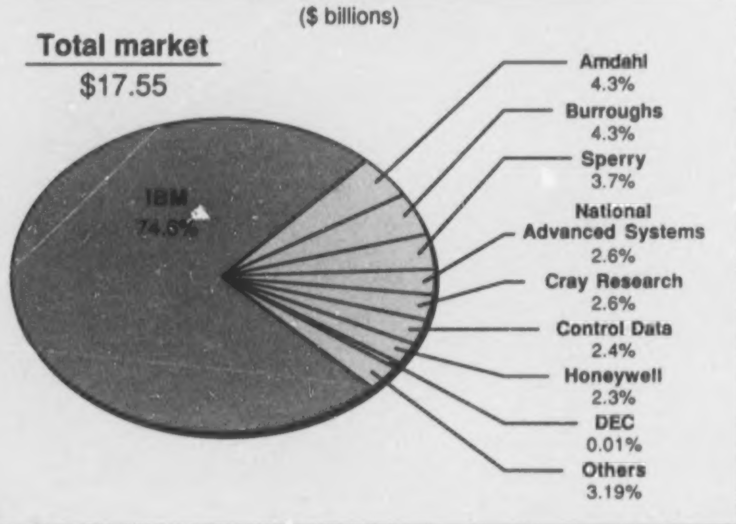
But even if that were to occur, agree most analysts, the mainframe's heyday is over. "I don't see it ever coming back to 20% growth," says Dataquest's Brown.

IBM's mainframe reliance

This is certainly bad news for IBM. Big Blue reportedly relies on mainframes for 25% of total revenue — which was $51.25 billion last year — and 50% of net income — which was $4.79 billion in 1986. This year, estimates the Yankee Group in Boston, shipments of IBM's 3090 series, the company's latest generation of mainframes commonly called Sierra, will drop 20%.

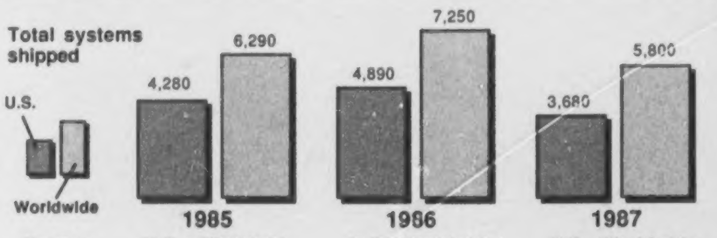
In January, IBM upgraded existing 3090 models with its E series processors. The result, says First Boston's

Mainframe market remained Blue through 1986



Source: International Data Corp.

Slowdown expected in the IBM mainframe market



System	1985 U.S.	1985 Worldwide	1986 U.S.	1986 Worldwide	1987 U.S.	1987 Worldwide
4361	1,230	1,760	1,300	1,800	1,500	2,200
4381	2,200	3,200	2,300	3,300	1,100	2,100
308x	500	830	270	450	100	200
3090	350	500	1,020	1,700	980	1,300
Total	4,280	6,290	4,890	7,250	3,680	5,800

Source: The Yankee Group

Milunovich, was a 10% increase in performance with no decrease in price. The lack of price cuts on the new systems, says IDC's Gens, reflects a fundamental slowness in demand. "IBM sees that cutting prices is not increasing demand," says Gens. "IBM is entering a period where there will be one or no price cuts a year."

That slackening of demand effects IBM more than other mainframe players. Concerning the market, says Gens: "IBM needs strong growth in all sectors." This is needed to fuel a significant rise in its sales, he concludes. Reportedly, a number of IBM's largest accounts are holding back on purchases. And that alone is having a negative impact on IBM's mainframe business and seemingly on the market.

Because when IBM suffers the entire market appears to falter. Even though demand has slowed in the mainframe market, today there is "spotty sluggishness," says IDC's Gens. Because IBM commands almost 75% of the market, Big Blue serves as a barometer for business. But that can be misleading.

Plug-compatible sales

IBM plug-compatible makers (PCMs) are expected to quadruple their combined shipments of mainframe systems this year. Amdahl Corp., Sunnyvale, Calif. — which designs its 5890 series of mainframes with components supplied by Fujitsu — is expected to ship between 250 systems and 300 systems in 1987. National Advanced Systems, the Mountain View, Calif., subsidiary of National Semiconductor Corp. — which buys its AS/XL series of mainframes from Hitachi — may ship close to 200 machines this year. Both Amdahl's 5890 line and NAS' AS/XL series are both comparable and compatible with IBM's 3090 family.

Demand is healthy for both Amdahl and NAS partly because both PCMs are in the midst of new product cycles. Amdahl first unveiled its 5890 series in October 1985 when the company introduced models 200, 300 and 600. In the beginning of this year, Amdahl added the uniprocessor model 190 and upgrades called the E series, to its other models. NAS also started out 1987 with additions to its AS/XL family, first introduced in 1985. Now the company has six AS/XL models — the 50, 60, 70, 80, 90 and 100 — which are comparable to IBM's 3090 200 and 400 in their range of performance.

Both Amdahl and NAS, according to company officials and analysts alike, have very attractive offerings. "We have a performance advantage over our prime competitor, which is IBM," says Wayne McIntyre, Amdahl's vice president for corporate marketing. Both Amdahl and NAS also have a price advantage; both Amdahl's 5890 models and NAS' AS/XL systems are 20% to 25% less than comparable IBM machines.

Mainframe buyers are also more likely now, says First Boston's Milunovich, to look at the PCMs' offerings. Both companies made it to market with their new generation of mainframes quicker than usual. In the past it has taken them up to two years to catch up with IBM; plug compatibles to IBM's 3090 series arrived to market a year after IBM's announcement. And many customers buy both IBM systems and an Amdahl or NAS machine to keep IBM honest, says IDC's Gens. "Our installed base, almost without exception, is also an IBM customer," says Amdahl's McIntrye.

IBM is pushing products designed to utilize mainframes for newer, less traditional jobs

But, the demand slowdown may catch up to the PCMs, too, by next year. Despite claims that hardware demand is robust, both Amdahl and NAS are in the process of diversifying their business' outside systems sales.

Amdahl's storage products division, which did not exist before 1983, last year accounted for 23% of sales, says McIntyre. Systems now represent 66% of revenue. The remaining 11% of sales is brought in by Amdahl's communications and software products. Amdahl, which does not offer in-house, or promote third-party, software applications, has a couple of R&D projects in process for software tools, designed to push processor performance, says McIntyre.

NAS, on the other hand, is focusing in on the engineering and scientific marketplace, particularly in the area of software applications. About 20% of NAS' systems sales go into that market, up from about 10% five years ago. Eventually, the company hopes to generate about one-third of its business in the scientific/engineering market. The impetus for NAS' directional shift is the company's vector processor add-on, similiar to, but reportedly twice as powerful as, IBM's vector processor, which gives mainframes the computer-intensive capabilities normally found on supercomputers.

To that end, NAS announced a software application development center in Atlanta this past March. There 31 software developers, formerly of Sperry Corp., will be developing both new applications and rewriting existing applications for the scientific/engineering user.

And IBM is pushing products designed to utilize mainframes for newer, less traditional jobs. NetView, initially announced a year ago with additions made last September, is a collection of five programs that manage networks tied into IBM mainframes. IBM is also expected to announce more communications links to MS-DOS, the operating system for its personal computers; and a version of SQL, its mainframe database, to run on the PC and enable smaller IBM systems to more easily tie into large IBM machines. In addition, IBM, which declined to comment on future products, is expected to make a software announcement concerning VM, its mainframe operating system, by midsummer.

The pack's attack

Outside IBM and the PCMs — which combined account for nearly 82% of the mainframe market — the players are the same but the names are changing. Burroughs and Sperry, with a combined market share of 8%, are now Unisys Corp. The merged company stresses its commitment to both companies' line of mainframes — the 1100 family and the V series — and announced new systems, the V 510 and V 530, in March. And the combined company, according to analysts, is maintaining its lead in both the airline industry (traditionally Sperry's turf) and banks (Burroughs' previous domain).

In addition, Unisys revised its fourth generation applications system generator — LINC II — which Unisys' Meier claims increases programmer productivity 10 to 20 times. The company is also increasing both in-house and third-party software applications, says Meier. All of this activity, says Meier, represents, "a gradual trend toward software sales [and] away from hardware sales."

Honeywell Inc. which claimed 2.3% of the market last year is, as of last March, Honeywell Bull. Now owned jointly by Compagnie des Machines Bull of France (42.5%), Honeywell (42.5%) and Japan's NEC Corp. (15%), the company, according to analysts, has little impact on the mainframe market today. But that could change.

Dataquest's Brown believes Honeywell Bull could prove to be the wildcard in the future large-systems market due to NEC, which is supposed to up its ownership to 42.5% by year-end. Brown anticipates that because the company will not be tied to IBM through compatibility issues, it will be free to push price/performance ratios higher. That in turn, says Brown, will push IBM. "If NEC boosts the performance [of its mainframes]," says Brown, "it could pass IBM." He concludes: "It may force IBM to do a better job."

Honeywell is also pushing its systems as database machines through a joint marketing agreement with Teradata Corp., a maker of back-end database processors. In addition, says George Olson, Honeywell's vice president for large systems, the company will soon be making both hardware and systems software announcements. Among these, says Olson, will be database and fourth-generation language products and enhancements to the company's transaction processing product, TP8. Mainframes, says Olson, "are moving from batch processing to on-line, transaction-processing applications."

Another new name has appeared on the block. In March, Digital Equipment Corp. announced new VAX systems — the 8974 and 8978 — based on four- and eight-clustered VAXes, respectively. But analysts say DEC's new systems will have little, if any, impact on the mainframe market. Even DEC declines the comparison.

> The end user does not care whether it's a mainframe or a supermini or a workstation getting the job done
>
> Bill Askins of DEC

"People have been saying DEC is positioning itself against IBM's 3090," says Bill Askins, DEC's high-performance systems marketing manager. For DEC, says Askins, "that is somewhat suicidal." But, Askin proceeds to compare the two systems in a number of ways. He says that the clustered systems represent the same performance as the 3090 machines for 40% less than IBM's price.

But the preclustered systems, says Askins, are designed as upgrades for existing customers. And they will probably be used predominantly as data centers that tie together a disparity of smaller systems. But that in itself could eventually prove a threat to mainframe sales. Says Askins: "Distributed processing is perceived as having value now. There are a lot more people who are computer literate and they don't care where the resources are." In other words, the end user does not care whether it's a mainframe or a supermini or a workstation getting the job done. Concludes Askins: "And the end user is driving the situation." ☐

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The most profitable companies of 1986

Despite all their complaints, makers of computers and computer products paced the electronics industry last year

By Al Furst and Linda Stallmann

For all their complaints about the slowdown in the computer industry, manufacturers of computers and computer-based systems were among the most profitable companies in the U.S. electronics industry last year.

In 1986, computer companies accounted for 10 of the top 25 most profitable electronics companies in the United States — based on profits and a percentage of sales. The list includes top-ranked supercomputer maker Cray Research Inc., which racked up an impressive 20.9% return on revenue; Altos Computer Systems Inc., No. 5, a multiuser computer vendor which weighed in at 15.1% profit-to-sales ratio; IBM, No. 17, which provided shareholders with $4.7 billion in profits on $51.2 billion in sales for a 9.3% profitability rate, despite relatively flat sales compared with one year earlier; and superminicomputer maker Digital Equipment Corp., No. 25, now IBM's most visible nemesis in the office computer environment.

Computer makers specializing in transaction processing also had nothing to be ashamed of. Both Tandem Computers Inc. (No. 24), the leader in fault-tolerant computers, and challenger Stratus Computer Inc. (No. 12), made it into the top 25 in 1986. Diebold Inc., a leading supplier of computer-based electronic banking systems, checked in at the No. 21 position. And ISC Systems Corp., which also markets automation systems for the banking industry, was No. 23.

Following on the heels of the computer vendors were a slew of disk drive makers specializing in 5.25-inch footprints. The list includes Quantum Corp. (No. 2); Miniscribe Corp. (No. 7); and Micropolis Corp. (No. 19), another leading drive maker.

Also present were firms offering a variety of computer-related products: AST Research Inc., No. 4, which claims to be the leading independent supplier of personal computer enhancement products; Digital Communications Associates Inc. (No. 6), makers of the ubiquitous Irma board for PC-to-mainframe communications; and Western Digital Corp. (No. 14), which supplies a broad range of storage management and communications controllers, in addition to enhanced peripherals products based on advanced semiconductor technology.

Computer companies involved in transaction processing were especially profitable in 1986

CAD/CAM charisma

While by no means dominant, computer-aided design and manufacturing (CAD/CAM) companies also took a leadership position last year. Intergraph Corp., the red-hot design automation leader from Huntsville, Ala., specializing in mechanical CAD/CAM applications, was No. 8 on our list; Evans & Sutherland Computer Corp., a supplier of high-end CAD/CAM systems for medical, military and miscellaneous applications, was No. 13; Gerber Scientific Inc., a capital equipment supplier with a strong base in the traditional CAD/CAM market, was No. 16; IBM, the undisputed leader in mechanical CAD/CAM (and a dozen other industry segments for that matter) was No. 17; and DEC, another force in CAD/CAM because of its undisputed leadership position in scientific computing, was No. 25.

Connector makers Molex Inc. (No. 10) and AMP Inc. (No. 20) paved the way for the computer segment. But noticeably absent this year from the top of our 1986 profitability chart were semiconductor makers which are still recovering from one of the bloodiest periods in the history of the semiconductor industry. In fact, Analog Devices Inc. and Monolithic Memories Inc. were among the few chip makers to even make it into the top 100 this year.

The award for the most profitably unique company on our list has to go to Cincinnati Microwave Inc. (No. 9), which we list on our table as a communications company. Cincinnati Microwave makes a pocket-sized radar warning system, which is a fancy way of saying "fuzz-buster."

To be considered for inclusion on our list, companies must be publicly held and generate at least 70% of their revenue from electronics. They also must have had at least $100 million in sales in 1986. Software and service companies are not included. ▷

Most profitable electronics companies

Rank	Company	Fiscal 1986 profits as a percentage of revenue	Fiscal 1986 revenue ($ millions)	Fiscal 1986 profits ($ millions)	Fiscal year ended (month/year)	Location
1	**Cray Research**	20.9%	$596.7	$124.8	12/86	Minneapolis, Minn.
2	**Quantum**	18.3%	121.2	22.2	3/86	Milpitas, Calif.
3	**Medtronic**	16.7%	402.8	67.4	4/86	Minneapolis, Minn.
4	**AST Research**	15.8%	172.3	27.2	6/86	Irvine, Calif.
5	**Altos Computer Systems**	15.1%	134.2	20.3	6/86	San Jose, Calif.
6	**Digital Communications**	14.9%	137.9	20.6	6/86	Alpharetta, Ga.
7	**MiniScribe**	12.3%	184.9	22.7	12/86	Longmont, Colo.
8	**Intergraph**	11.6%	605.7	70.4	12/86	Huntsville, Ala.
9	**Cincinnati Microwave**	11.3%	102.1	11.5	12/86	Cincinnati, Ohio
10	**Molex**	11.0%	291.9	32.0	6/86	Lisle, Ill.
11	**Measurex**	10.9%	192.7	21.1	11/86	Cupertino, Calif.
12	**Stratus Computer**	10.9%	124.6	13.5	12/86	Marlboro, Mass.
13	**Evans-Sutherland**	10.0%	109.3	10.9	12/86	Salt Lake City, Utah
14	**Western Digital**	9.9%	279.4	27.8	6/86	Irvine, Calif.
15	**Telex**	9.5%	709.2	67.5	3/86	Tulsa, Okla.
16	**Gerber Scientific**	9.5%	191.8	18.2	4/86	South Windsor, Conn.
17	**IBM**	9.3%	51,250.0	4,789.0	12/86	Armonk, N.Y.
18	**Electrospace Systems**	9.2%	145.0	13.4	3/86	Richardson, Texas
19	**Micropolis**	8.6%	213.1	18.3	12/86	Chatsworth, Calif.
20	**AMP**	8.5%	1,933.0	164.0	12/86	Harrisburg, Pa.
21	**Diebold**	8.4%	413.7	34.9	12/86	Canton, Ohio
22	**Pitney Bowes**	8.4%	1,986.7	166.1	12/86	Stamford, Conn.
23	**ISC Systems**	8.3%	166.1	13.9	6/86	Spokane, Wash.
24	**Tandem Computers**	8.3%	767.8	63.8	9/86	Cupertino, Calif.
25	**DEC**	8.1%	7,590.4	617.4	6/86	Maynard, Mass.
26	**Apple Computer**	8.1%	1,901.9	154.0	9/86	Cupertino, Calif.
27	**Timeplex**	8.0%	119.1	9.6	6/86	Woodcliff Lake, N.J.
28	**Loral**	8.0%	663.8	53.0	3/86	New York, N.Y.
29	**Dynatech**	8.0%	256.7	20.4	3/86	Burlington, Mass.
30	**Avantek**	7.7%	208.2	16.1	12/86	Santa Clara, Calif.
31	**Wyse Technology**	7.6%	166.4	12.6	3/86	San Jose, Calif.
32	**Seagate Technology**	7.5%	459.8	34.5	6/86	Scotts Valley, Calif.
33	**Xidex**	7.5%	432.3	32.2	6/86	Mountain View, Calif.
34	**Hewlett-Packard**	7.3%	7,102.0	516.0	10/86	Palo Alto, Calif.
35	**Emulex**	7.1%	104.9	7.5	6/86	Costa Mesa, Calif.
36	**Analog Devices**	7.0%	334.4	23.4	10/86	Norwood, Mass.
37	**NCR**	6.9%	4,881.6	336.5	12/86	Dayton, Ohio
38	**Data Card**	6.9%	153.6	10.6	3/86	Minneapolis, Minn.
39	**Symbolics**	6.9%	114.2	7.9	6/86	Concord, Mass.
40	**COMPAQ Computer**	6.9%	625.2	42.9	12/86	Houston, Texas
41	**Analogic**	6.8%	148.2	10.1	7/86	Peabody, Mass.
42	**Watkins-Johnson**	6.8%	255.4	17.2	12/86	Palo Alto, Calif.
43	**Micom Systems**	6.7%	189.5	12.7	3/86	Simi Valley, Calif.
44	**Siliconix**	6.6%	111.2	7.4	12/86	Santa Clara, Calif.
45	**Tandy**	6.6%	3,036.0	200.6	6/86	Fort Worth, Texas
46	**Bolt Beranek and Newman**	6.4%	178.0	11.3	6/86	Cambridge, Mass.
47	**Mentor Graphics**	6.3%	173.5	11.0	12/86	Beaverton, Ore.
48	**MTS Systems**	6.3%	109.8	6.9	9/86	Minneapolis, Minn.
49	**Adams-Russell Electronics**	5.9%	113.1	6.7	9/86	Waltham, Mass.
50	**John Fluke**	5.8%	209.0	12.2	9/86	Everett, Wash.

Source: ELECTRONIC BUSINESS

(Continued)

Most profitable electronics companies (continued)

Rank	Company	Fiscal 1986 profits as a percentage of revenue	Fiscal 1986 revenue ($ millions)	Fiscal 1986 profits ($ millions)	Fiscal year ended (month/year)	Location
51	**Perkin-Elmer**	5.6%	$1,290.6	$72.6	7/86	Norwalk, Conn.
52	**Prime Computer**	5.5%	860.2	46.9	12/86	Natick, Mass.
53	**E-Systems**	5.4%	1,135.1	61.6	12/86	Dallas, Texas
54	**Conrac**	5.1%	153.9	7.8	12/86	Stamford, Conn.
55	**Aydin**	5.1%	136.8	7.0	12/86	Horsham, Pa.
56	**Logicon**	5.0%	200.5	10.0	3/86	Torrance, Calif.
57	**Storage Technology**	4.9%	343.1	16.8	12/86	Louisville, Colo.
58	**Andrew**	4.8%	197.7	9.5	9/86	Orland Park, Ill.
59	**AEL Industries**	4.5%	104.9	4.7	2/86	Lansdale, Pa.
60	**Cipher Data Products**	4.4%	163.0	7.2	6/86	San Diego, Calif.
61	**Monolithic Memories**	4.3%	204.9	8.9	9/86	Santa Clara, Calif.
62	**Amdahl**	4.3%	966.3	41.8	12/86	Sunnyvale, Calif.
63	**California Microwave**	4.2%	104.4	4.4	6/86	Sunnyvale, Calif.
64	**BRIntec**	4.1%	310.7	12.7	12/86	Willimantic, Conn.
65	**Decision Industries**	4.0%	195.1	7.8	11/86	Horsham, Pa.
66	**Gould**	3.8%	908.9	34.6	12/86	Rolling Meadows. Ill.
67	**Xerox**	3.8%	12,900.0	488.0	12/86	Stamford, Conn.
68	**Recognition Equipment**	3.7%	241.8	9.0	10/86	Irving, Texas
69	**DSC Communications**	3.6%	304.0	11.0	12/86	Plano, Texas
70	**Burr-Brown**	3.3%	112.8	3.7	12/86	Tucson, Ariz.
71	**Motorola**	3.3%	5,888.0	194.0	12/86	Schaumburg, Ill.
72	**Applied Magnetics**	3.2%	128.1	4.1	9/86	Goleta, Calif.
73	**Anthem Electronics**	3.0%	104.5	3.1	3/86	San Jose, Calif.
74	**Tracor**	3.0%	632.1	18.8	12/86	Austin, Texas
75	**Systems Industries**	3.0%	103.3	3.1	7/86	Milpitas, Calif.
76	**SCI Systems**	2.9%	470.2	13.8	6/86	Huntsville, Ala.
77	**Tektronix**	2.9%	1,352.2	39.3	5/86	Beaverton, Ore.
78	**Triad Systems**	2.8%	111.7	3.2	9/86	Sunnyvale, Calif.
79	**Diasonics**	2.7%	217.1	5.9	12/86	Milpitas, Calif.
80	**Harris**	2.7%	2,216.6	59.6	6/86	Melbourne, Fla.
81	**Apollo Computer**	2.4%	391.7	9.3	12/86	Chelmsford, Mass.
82	**Emerson Radio**	2.3%	566.3	12.9	3/86	North Bergen, N.J.
83	**Nicolet Instruments**	2.3%	126.4	2.9	3/86	Madison, Wis.
84	**General DataComm Industries**	2.2%	178.0	3.9	9/86	Middlebury, Conn.
85	**LSI Logic**	2.0%	194.3	3.9	12/86	Milpitas, Calif.
86	**Wang Laboratories**	1.9%	2,643.0	50.9	6/86	Lowell, Mass.
87	**Rogers**	1.8%	128.8	2.3	12/86	Rogers, Conn.
88	**N.A. Philips**	1.8%	4,531.6	81.2	12/86	New York, N.Y.
89	**Avnet**	1.7%	1,415.6	23.9	6/86	New York, N.Y.
90	**Wyle Laboratories**	1.4%	307.0	4.3	1/87	El Segundo, Calif.
91	**Coherent**	1.3%	138.2	1.7	9/86	Palo Alto, Calif.
92	**Marshall Industries**	1.2%	244.8	2.9	5/86	El Monte, Calif.
93	**Sun Electric**	1.1%	177.0	1.9	10/86	Crystal Lake, Ill.
94	**Compugraphic**	1.0%	341.1	3.4	12/86	Wilmington, Mass.
95	**Applied Materials**	0.8%	149.3	1.2	10/86	Santa Clara, Calif.
96	**Texas Instruments**	0.8%	4,970.0	39.9	12/86	Dallas, Texas
97	**Key Tronic**	0.5%	111.7	0.6	6/86	Spokane, Wash.
98	**Data General**	0.5%	1,268.0	5.7	9/86	Westboro, Mass.
99	**Spectra-Physics**	0.4%	210.1	0.8	9/86	San Jose, Calif.
100	**Cubic**	0.3%	337.8	1.1	9/86	San Diego, Calif.

Source: ELECTRONIC BUSINESS

(Continued)

Most profitable electronics companies by industry segment

Capital equipment

Company	Fiscal 1986 profits as a percentage of revenue	Rank
Gerber Scientific	9.5%	16
Hewlett-Packard	7.3%	34
John Fluke	5.8%	50
Perkin-Elmer	5.6%	51
Tracor	3.0%	74
Tektronix	2.9%	77
Nicolet Instruments	2.3%	83
Applied Materials	0.8%	95
Spectra-Physics	0.4%	99
Weighted average	**6.1%**	

Communications

Company	Fiscal 1986 profits as a percentage of revenue	Rank
Digital Communications	14.9%	6
Cincinnati Microwave	11.3%	9
Timeplex	8.0%	27
Dynatech	8.0%	29
Avantek	7.7%	30
Micom Systems	6.0%	43
Bolt Beranek and Newman	6.4%	46
Adams-Russell Electronics	5.9%	49
Andrew	4.8%	58
California Microwave	4.2%	63
DSC Communications	3.6%	69
Motorola	3.3%	71
General DataComm Industries	2.2%	84
Weighted Average	**4.2%**	

Components

Company	Fiscal 1986 profits as a percentage of revenue	Rank
Molex	11.0%	10
Western Digital	9.9%	14
AMP	8.5%	20
Analog Devices	7.0%	36
Siliconix	6.6%	44
Monolithic Memories	4.3%	61
BRIntec	4.1%	64
Burr-Brown	3.3%	70
Motorola	3.3%	71
LSI Logic	2.0%	85
Rogers	1.8%	87
Texas Instruments	0.8%	96
Weighted average	**3.5%**	

Computers

Company	Fiscal 1986 profits as a percentage of revenue	Rank
Cray Research	20.9%	1
Altos Computer Systems	15.1%	5
Stratus Computer	10.9%	12
Telex	9.5%	15
IBM	9.3%	17
Tandem Computers	8.3%	24
DEC	8.1%	25
Apple Computer	8.1%	26
Hewlett-Packard	7.3%	34
NCR	6.9%	37
Symbolics	6.9%	39
COMPAQ Computer	6.9%	40
Analogic	6.8%	41
Tandy	6.6%	45
Prime Computer	5.5%	52
Amdahl	4.3%	62
SCI Systems	2.9%	76
Apollo Computer	2.4%	81
Texas Instruments	0.8%	96
Data General	0.5%	98
Weighted average	**8.1%**	

Defense electronics

Company	Fiscal 1986 profits as a percentage of revenue	Rank
Electrospace Systems	9.2%	18
Loral	8.0%	28
Watkins-Johnson	6.8%	42
E-Systems	5.4%	53
Aydin	5.1%	55
Logicon	5.0%	56
AEL Industries	4.5%	59
Motorola	3.3%	71
Harris	2.7%	80
Texas Instruments	0.8%	96
Cubic	0.3%	100
Weighted average	**2.9%**	

Distributors

Company	Fiscal 1986 profits as a percentage of revenue	Rank
Anthem Electronics	3.0%	73
Emerson Radio	2.3%	82
Avnet	1.7%	89
Wyle Laboratories	1.4%	90
Marshall Industries	1.2%	92
Weighted average	**1.8%**	

Computer-based systems

Company	Fiscal 1986 profits as a percentage of revenue	Rank
Intergraph	11.6%	8
Measurex	10.9%	11
Evans-Sutherland	10.0%	13
Diebold	8.4%	21
ISC Systems	8.3%	23
Hewlett-Packard	7.3%	34
Data Card	6.9%	38
MTS Systems	6.3%	48
Recognition Equipment	3.7%	68
Triad Systems	2.8%	78
Coherent	1.3%	91
Sun Electric	1.1%	93
Compugraphic	1.0%	94
Weighted average	**7.1%**	

Peripherals

Company	Fiscal 1986 profits as a percentage of revenue	Rank
Quantum	18.3%	2
AST Research	15.8%	4
MiniScribe	12.3%	7
Micropolis	8.6%	19
Wyse Technology	7.6%	31
Seagate Technology	7.5%	32
Xidex	7.5%	33
Emulex	7.1%	35
Conrac	5.1%	54
Storage Technology	4.9%	57
Cipher Data Products	4.4%	60
Decision Industries	4.0%	65
Applied Magnetics	3.2%	72
Systems Industries	3.0%	75
Key Tronic	0.5%	97
Weighted average	**7.4%**	

Office equipment

Company	Fiscal 1986 profits as a percentage of revenue	Rank
IBM	9.3%	17
Pitney Bowes	8.4%	22
NCR	6.9%	37
Xerox	3.8%	67
Harris	2.7%	80
Wang Laboratories	1.9%	86
Weighted average	**7.8%**	

Source: ELECTRONIC BUSINESS

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CAE/CAD/CAM market shifts away from turnkey sales

Programmable controllers move toward a $5 billion business

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Du Pont's Henry: Spearheading a $1.3 billion electronics thrust

QUALITY QUEST

The secret behind DEC's product machine

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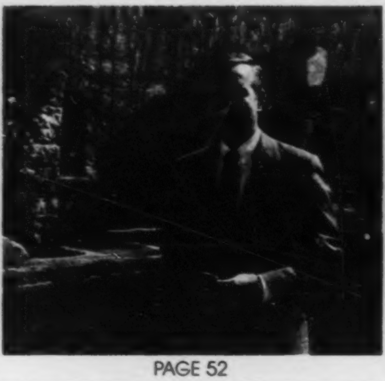

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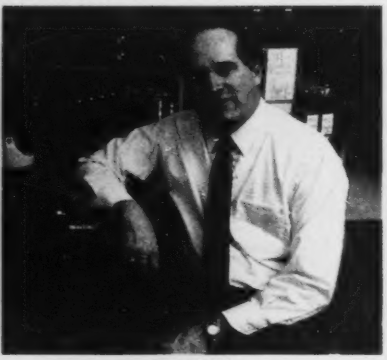

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Cover photo/Bill Fitch

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BPA ABP

Passive component makers started 1987 actively

AVX gloats over lots of capacitance, but PCB shops suffer from lots of capacity

Marshall D. Butler claims that he accurately called the recent major turning points in the U.S. electronics business. He called it the first time in September 1984, when business turned down at the start of the longest recession that the U.S. market for electronic components had suffered in the past 30 years. Then, again in November 1986, for what he believes (and most forecasters now agree) was the beginning of the upturn from that recession.

The chairman of AVX Corp. attributes his accurate calls not to prescience but to product: multilayer ceramic capacitors, the tiny components that can pack a lot of capacitance in a small volume. As a leading manufacturer of MLCs — the largest in the world, according to Butler — AVX enjoys a privileged view of business conditions in the electronic component market which allows it to see the turning points faster than any other component maker. The reason, Butler is fond of explaining, is that the U.S. market for MLCs perfectly replicates the whole U.S. market for ICs. Large as they are, none of the IC makers has a share of the IC market as large as AVX has of the MLC market. Hence, his is a better view.

So far, Butler says, the view is very encouraging. AVX's sales for the first quarter of this year were 29% ahead of last year's. Besides, he adds, the company's first quarter was up 21% over the last quarter of 1986, making it two up quarters in a row. This is what he finds encouraging, because he sees it as reflecting actual demand. By comparison, there was only an ephemeral improvement last year when his customers had to replenish their depleted inventories. Back in 1985 and 1986, he says, AVX's customers were selling inventoried equipment they didn't have to make, or making equipment with inventoried capacitors they didn't have to buy.

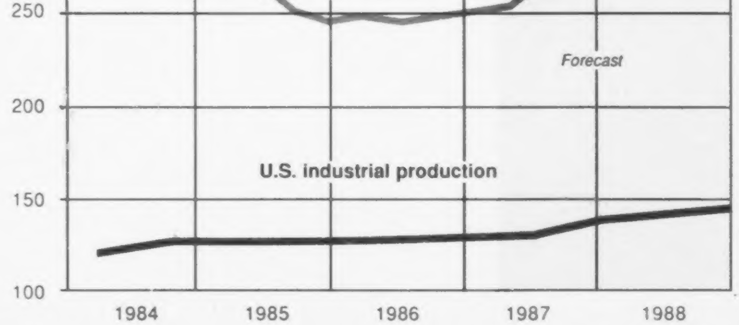
The official figures from the U.S. Department of Commerce are beginning to confirm Butler's optimism. After dropping 8% in 1985 and 6% in 1986, the industrial production index for electronic components (SIC 367) was up for the first quarter of this year by 3% over the same quarter in 1986. Even though this index is heavily influenced by semiconductor production, it is the only one that gives market watchers a glimpse of activity by manufacturers of components other than semiconductors (passive, electromechanical and interconnection components).

For example, for The Cherry Corp., an important manufacturer of switches for electronics applications (formerly known as Cherry Electrical Products Corp.) the first quarter was almost as good as for AVX, up 26% over last year's. Interconnection components also show strength, except for printed circuit boards which are still suffering from overcapacity among PCB makers, even among makers of multilayer boards. Cahners economist Cheryl Patstone forecasts that the industrial production index for SIC 367 will increase by 10% in 1987. This is good news for makers of passive components, just at the time when many are becoming orphans from the large parents that bought them in the past decade. TRW Inc. sold its capacitor factory and divested resistor maker IRC. The Penn Central Corp. is trying to divest Sprague Electric, the leading manufacturer of capacitors (of all types) in the United States, and Union Carbide Corp. still hasn't found a buyer for Kemet, which is AVX's strongest competitor.

ALBERTO SOCOLOVSKY

Electronic components

Industrial production indexes, 1977 = 100



Historical data: Federal Reserve Board
Forecast: Cahners Economics

New orders

In the fourth quarter of last year, manufacturers of computers and office machines received $15.71 billion in new orders, a decrease of 2.6% from the year-ago period, but up significantly from the third quarter's $13.33 billion. There was further evidence of a computer industry rebound in early 1987; preliminary reports show that orders rose modestly on a year-to-year basis (the first such gain since summer 1985). Rising foreign demand resulting from the weaker dollar, new product cycles and an upturn in domestic capital investment will join together to sustain the industry's current climb in 1987 and 1988. Orders, which fell 11.8% in 1986, are expected to rebound 11.4% this year.

Shipments

Although orders began to rise last summer and showed particularly encouraging results in early 1987, shipments have yet to improve substantially. During last year's fourth quarter, manufacturers shipped $16.27 billion worth of equipment, a seasonal increase over the third quarter's $13.74 billion, but down 8.2% compared with the year-ago quarter. Annually, shipments reached $56.23 billion, a 9.6% loss from the previous year. Shipments are expected to climb 5.2% this year, with most of the growth occurring in the second half of the year.

Unfilled orders

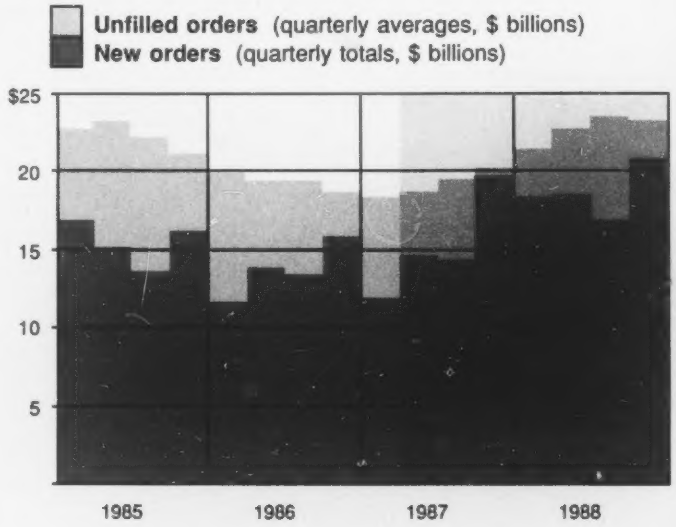
Manufacturers' order backlogs declined to $18.81 billion in the fourth quarter of 1986, their lowest level in more than three and a half years. This was the sixth consecutive period of decline. Early reports for the first quarter of 1987 indicate that backlogs will post another modest decrease. However, rising order rates should cause them to gradually increase over the remainder of the year. At the end of 1986, backlogs were running nearly 10% below the year-earlier level. By this December, they should be up more than 7%, with a further gain of 16.3% expected by year-end 1988.

Inventory-to-shipment ratio

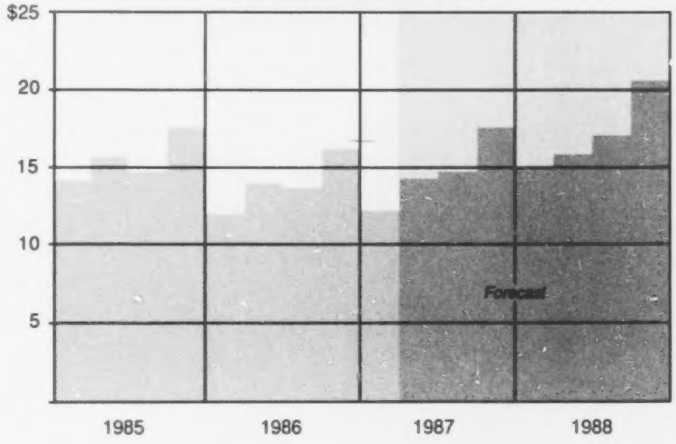
The ratio of manufacturers' inventories to shipments fell slightly from 2.20 to 2.16 in the fourth quarter of 1986. This decrease was largely a reflection of ongoing cutbacks in the level of inventories, which were valued at approximately $10.07 billion in the final quarter, down from a peak of $13.59 billion at the start of 1985. Early data for this year's first quarter suggest that the I/S ratio will stabilize at about 2.15, implying that inventories have finally reached the desired balance with shipments. Although manufacturers may increase their inventory buffers over the next several months, we expect the ratio to remain fairly close to its present level throughout 1987.

Office and computing equipment

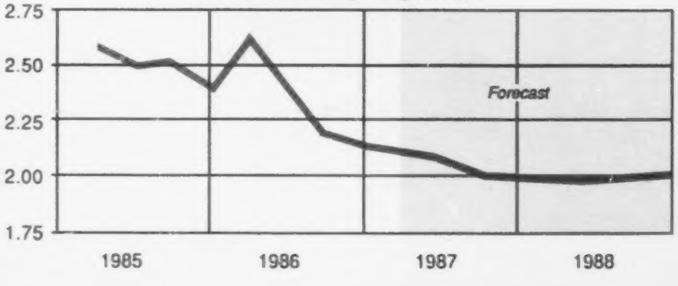
(SIC 357)



Office and computing equipment: Shipments
(quarterly totals, $ billions)



Office and computing equipment:
Inventory-to-shipment ratio
(seasonally adjusted)



Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

Communication equipment

(SIC 366)

New orders

Communication equipment manufacturers received $18.94 billion worth of new orders in the fourth quarter of 1986, an increase of 4.4% over the year-ago quarter. But the degree of improvement was too small to prevent the year from posting a loss; orders totaled only $73.22 billion, down 3.6% from $75.97 billion in 1985. Demand for nondefense products (which comprise about half of the industry total) has recently begun to pick up after a protracted slump in 1985 and 1986. However, the positive effects of this turnaround will be dampened by a slackening in the military-communications area. The result will be a modest gain in orders of only 1.5% in 1987. A healthier increase of 15.3% is expected in 1988.

Shipments

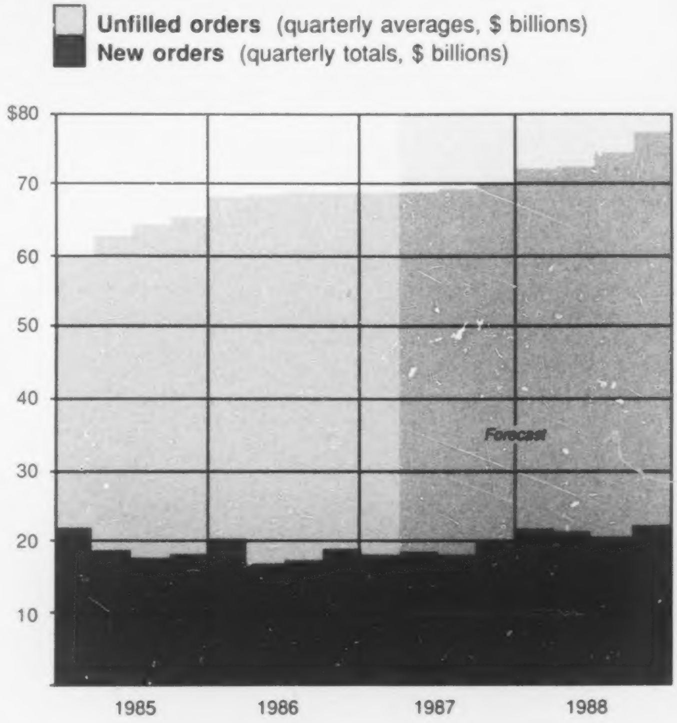
Manufacturers shipped an estimated $19.14 billion worth of equipment in last year's fourth quarter, an increase of more than $2 billion over the traditionally slow summer quarter. For the year, shipments were up 6.6%. Carryover funding for military programs, which was the principal source of market growth last year, will provide far less stimulus in 1987. Shipments are expected to climb 4.9% in 1987, reaching a total of $73.13 billion. In 1988, a pickup in the nondefense industries will bring increased business investment, causing growth to improve at an 8.2% rate.

Unfilled orders

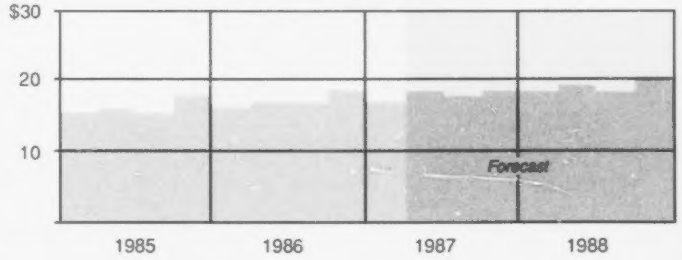
Order backlogs in the communication equipment industry reached a fourth-quarter average of $69.35 billion, an increase of just 0.2% compared with the third quarter. More important, year-end backlogs stood merely 5.3% ahead of the previous December's level. Projections for modest increases in both orders and shipments in 1987 suggest that backlogs are in for a relatively flat year, probably growing 1% to 2% annually. The gain in 1988 will be much stronger, although still lackluster by recent standards. Backlogs should grow to $77.6 billion by next December, up approximately 10% from the end of this year.

Inventory-to-shipment ratio

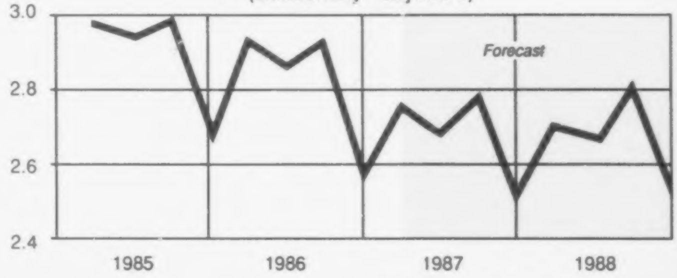
The ratio of manufacturers' inventories to shipments averaged 2.57 in the fourth quarter of 1986, down from 2.94 in the preceding quarter. This decrease was caused largely by a reduction of more than $400 million in inventories between August and December of last year. Manufacturers will have little incentive to build inventory cushions this year if growth turns out to be as modest as expected. Thus, the I/S ratio should stay within a tightly controlled range of 2.5 to 2.8 throughout 1987 and into the first half of 1988.



Communication equipment: Shipments
(quarterly totals, $ billions)



Communication equipment: Inventory-to-shipment ratio
(seasonally adjusted)



Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

Programmable controllers move toward a $5 billion business

Despite a sluggish 1987, controllers will post strong growth; but not without standardization

A primary goal in the $940 million worldwide programmable controller market is to make tomorrow's factory of the future today's reality. The idea is to link the factory floor — the domain of programmable controllers — to the corporate communication network in order to improve productivity and usher in the age of a truly computer-integrated manufacturing (CIM) environment. This is easier said than done. But, as controllers become more sophisticated, the leading vendors are poised to capture their share of the growing factory automation market.

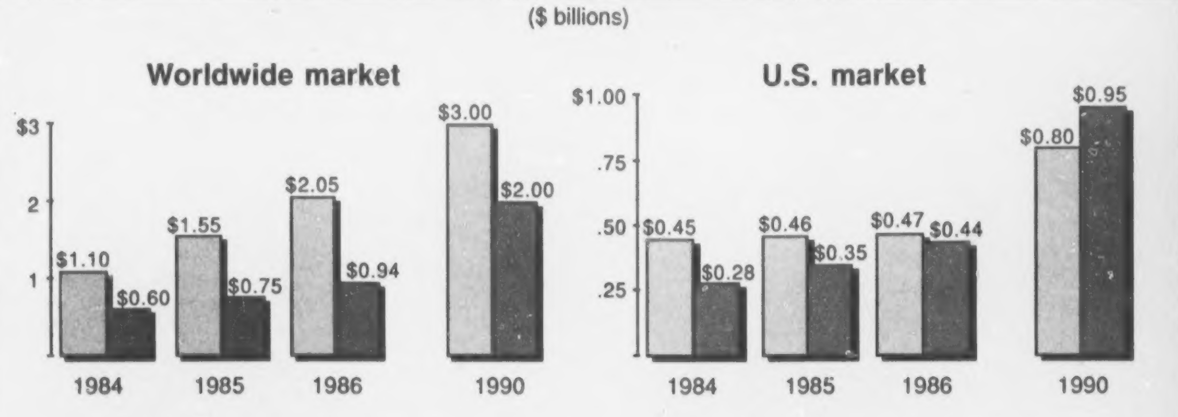
Currently, there is confusion on the shop floor. It is tough to link vendors' equipment together to create a truly CIM environment when the equipment talks different languages. This confusion is contributing to the slow growth, forecast at between 0% and 5%, for programmable controllers in 1987. But, vendors and analysts agree, it is only a short-term dip in a business with promising long-term prospects.

The programmable controller market will hum along at close to a 20% clip through the end of the decade, says Julius Dorfman, president of CIMdata Inc., a Wellesley Hills, Massachusetts-based consulting and CIM market services firm. The U.S. market for programmable controllers accounts for almost half of the total worldwide market and will grow from $440 million in 1986 to $950 million by 1990, predicts Dorfman. Others, however, put the market figures at closer to $600 million for 1986. But, despite this disparity, most industry experts agree that by 1992 the domestic industry will be over $1 billion.

Programmable controllers were initially designed as replacements of electromechanical relays back in the early 1970s. And, like the personal computer that has radically changed the office environment, programmable controllers have done a lot to change the factory environment. Because they are the first level of factory automation, programmable controllers play a crucial role in the CIM environment. The attention by vendors has been on upward integration of these black boxes. Today, many programmable controller vendors are in the cell controller market — units that control clusters of programmable controllers — as well as the industrial computer market.

But this bottom-up strategy has competition. The consultants and systems integrators that are preaching the wonders of CIM prefer the top-down strategic approach. That is, tackling the issue of automation from the executive suite and fitting the factory into the corporate framework. The trick is to assimilate these two schools of thought. There is the vague expectation that the top-down and bottom-up camps will meet some-

Factory-floor controllers market



Source: CIMdata Inc.

where in the middle.

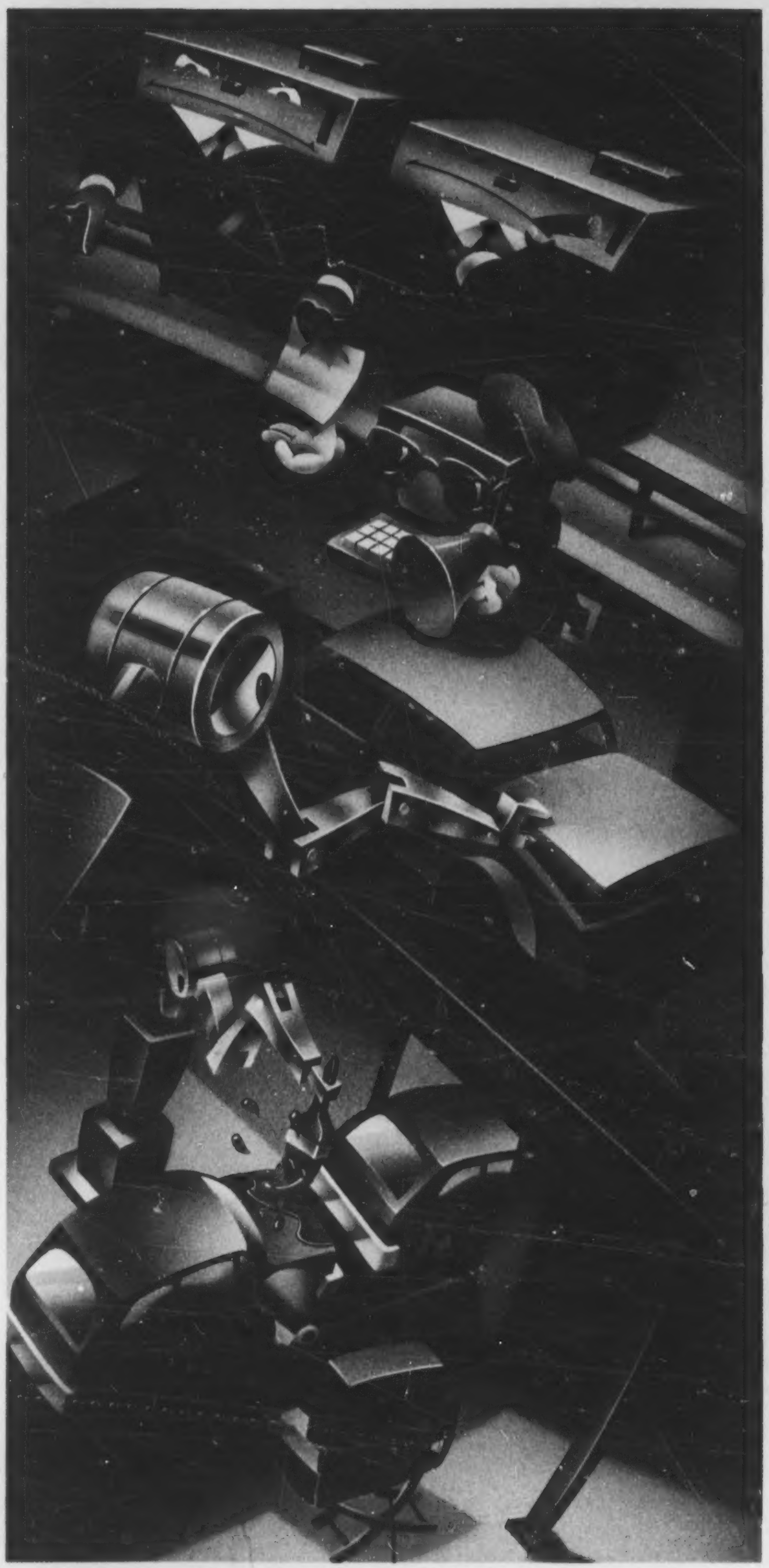
George Dancu, a management consulting services partner in the Pittsburgh office of Coopers & Lybrand, a Big Eight accounting firm that does top-down consulting, believes that the factory automation market will reach $50 billion by the early 1990s. He stresses the necessity for the corporate office and the factory floor to reconcile the top-down and bottom-up philosophies. Without reconciliation and standardization, that $50 billion market will be much smaller. This middle ground — the cell controller and industrial computer market — is where the money is to be had. The factory of the future, says Dancu, will be built by a multitude of vendors as no one vendor can satisfy all of the requirements.

Controlling factors

Much of the expected growth in the programmable controllers market is dependent on factors beyond the control of vendors. At the top of the list is the general health of the U.S. automotive industry — a major customer of programmable controllers — that is in the throes of more shutdowns and layoffs. In 1985, the automotive industry spent $5 billion on factory automation, $255 million of which was for programmable controllers, reports Arthur D. Little Inc., a Boston-based research and consulting firm.

Another factor in the growth equation is the increasing competition in the U.S. market from Japanese vendors. Many U.S. controller companies now buy low-end microprogrammable controllers from Japanese producers and are also looking to form strategic alliances where possible. The leading Japanese computer numerical control company, Fanuc Ltd., established a joint venture with General Electric Co. earlier this year [ELECTRONIC BUSINESS, March 15, 1987 p32].

But, some Japanese programmable controller companies are not so sure they want to team up with American vendors. Mitsubishi Electric Sales America Inc., a top programmable controller maker wants to go it alone in its penetration of the American market, says Robert Sore, New England area manager for the company. He claims that Mitsubishi has had repeated offers from major U.S. factory automation companies, but it has declined all joint-venture offers. Mitsubishi has been in the United States for four years, Sore says, and has



Programmable controllers will link the factory floor to the corporate communication network

Dave Joly

broadened its product offering to include not only microprogrammable controllers but also medium- and high-end units.

Competition is also fierce from West Germany's Siemens AG and the U.S. subsidiary, Seimens Energy and Automation Inc. In its attempt to capture a portion of the small-unit market away from the Japanese, Siemens recently unveiled a new line of low-end products. The reason, says Raymond Leveille, vice president and general manager of the programmable controls division for Siemens' American company, is because of the expected decline in demand for the larger programmable controllers.

Besides the competition and the ailing health of segments of smokestack America, there is the nagging issue of when a universally accepted communication protocol will take hold in the factory automation marketplace. Manufacturing automation protocol (MAP) is widely endorsed by domestic and international standards boards as well as a growing number of vendors, but it is still not widely used. In Britain it is virtually nonexistent and it is just now getting a toehold in the European continent. There is even dissension in the U.S. ranks as to MAP's viability. As a result, vendors have their own proprietary systems and are aggressively pushing them both domestically and internationally.

It is in the international marketplace that the strongest growth for factory automation exists. The need for domestic programmable controller vendors to become world-class players is vitally important for their long-term staying power and their ability to capture international business. Predictably, Asia is looked at as the hottest market right now.

The 50-50, $200 million GE-Fanuc joint venture puts this third-ranked programmable controller company in a very good position to milk the Far Eastern market. Robert P. Collins, chief executive of GE-Fanuc, North America Automation, claims that the Asian market for programmable controllers will grow at over 25% for the next five years. Europe will post growth rates averaging between 5% and 10%, while America will show static or slow growth for the same five-year period, he predicts. Collins insists that a global market strategy is the only way to access the world marketplace.

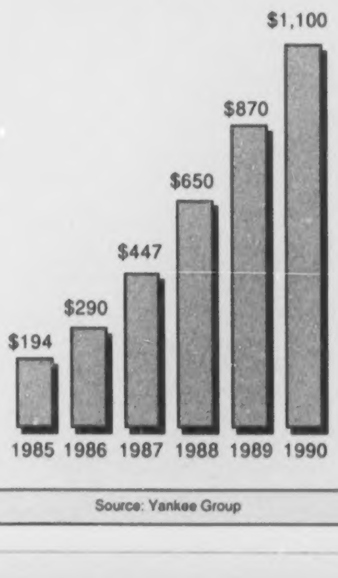
Fifth-ranked Square D Co., the low-profile programmable controller company headquartered in Palatine, Ill., is attempting to spruce up its operation by injecting some new blood into its organization. Jerre L. Stead, president and chief operating officer since January of this year, joins Square D from Honeywell Inc. and intends to turn the stodgy manufacturer into a world-class player. With only 15% of the company's business conducted overseas, Stead says that he is looking to establish a relationship with a Far East company before the end of the year. Similarly, Europe offers Square D a "tremendous growth potential," he adds.

> World-class status combined with a broader product offering is also the intention of top-ranked Allen-Bradley

One Asian market that few programmable controller makers are overlooking is the emerging Chinese market. As a new wave of industrialization takes hold, most leading firms are ensuring that they have some presence in China and are looking to grow that presence in the future. Second-ranked Gould Electronics has been producing programmable controllers in China under a licensing agreement since 1984. The contract is for 10 years and is valued at $12 million or more, the company reports.

Cell controllers: The missing link and the new frontier

U.S market ($ millions)



Source: Yankee Group

Similarly, Texas Instruments Inc., the fourth-ranked programmable controller vendor, has equipment in over 250 Chinese sites, claims M. Mac McDonnell, vice president of TI's industrial systems division, based in Johnson City, Tenn. TI has been in the business since the late 1970s and has dedicated salespeople in Australia, China, Japan, Korea, Singapore and Taiwan, McDonnell says. The company's goal for 1987 is to become a world-class manufacturer and it is planning on a year of growth, despite the expectations of a flat market, adds McDonnell. He claims that TI's share of the market grew in 1986 as a result of the move in 1984 to broaden the product offering. The company is at loggerheads with GE-Fanuc over the No. 3 position.

Allen-Bradley's strategy

World-class status combined with a broader product offering is also the intention of top-ranked Allen-Bradley Co. With between 40% and 50% of the programmable controller market, the Rockwell International company is aggressively pursuing a position as the one-stop factory automation shop through its five-layer "Productivity Pyramid" concept of factory integration. The glue that bonds these levels of computer control is the communication network and Allen-Bradley believes it has all of the communication permutations covered. According to Richard Ryan, director for marketing at AB's communication division, the communication system in the factory of the future will not be one single protocol. Instead, he argues, it will include the best elements of proprietary networks, MAP, Digital Equipment Corp.'s EtherNET and possibly other protocols.

Ryan speculates that in a typical CIM environment, AB's proprietary baseband local area network — known as Data Highway — will be used for the factory floor, while MAP will be used to link programmable controllers to the factory-wide computer. From this level up, an EtherNET link will tie the factory to the office network. AB has products that can satisfy the needs of all of these levels of communication. The market leader recently signed an agreement with IBM to market Big Blue's 7552 industrial computer as the AB 6122 industrial support computer. With AB software, this system monitors programmable controllers through the Data Highway carrier band.

In the shadow of the powerful Allen-Bradley, second-place Gould has been losing market share over the past few years. But, now with new product offerings, the company is trying to put its house back in order. It is estimated that AB and Gould together control between 60% and 70% of the programmable controller market.

Charles Downey Jr., Gould's vice president for marketing with the industrial automation systems division, admits that the company missed the shift in the marketplace earlier in the decade when demand was growing for systems solutions. Gould persisted in making black boxes — albeit good black boxes — but they were not what industry was buying, says Downey. Specifically, demand was on the rise for cell controllers, the second level of intelligence up from the factory floor. Gould now offers cell controllers, industrial computers, and a range of systems integration and software services. These include its own proprietary communication standard for its range of controllers as well as MAP.

Keith Belton, an analyst at the Boston-based Yankee Group, claims the cell controller market is a critical link in a CIM framework. Total U.S. sales for the cell control market in 1986 were $290 million and will grow at a rate of 54% this year, Belton says. By 1990, cell controllers will break the $1 billion mark, he predicts.

Because the cell controller is the second level of intelligence in the bottom-up integration strategy, the market is attracting interest from more than just the traditional programmable controller vendors. DEC, Hewlett-Packard Co. and IBM are all in the running with their own ruggedized boxes, as are the traditional players. Between the cell controller and the programmable controller, communication is not a problem. It becomes an issue, however, when the cell controller attempts to communicate upward with the factory-wide MRP or the corporate-wide MIS system.

> What is clear is that without some degree of standardization, CIM will continue to be only a pipe dream

Filling a void

William Rolland, manager for industrial automation at the National Electrical Manufacturers Association (NEMA), sees cell controllers filling the void between the factory floor and the corporate computer system: but, only if a standard exists. Together with the Geneva-based International Electrotechnical Commission (IEC), NEMA is pushing to get the MAP standard approved. (MAP 3.0, the first truly multivendor protocol, will not be out until mid-1988.) A standard is crucial, Roland says, because no one vendor can provide all of the products and services needed to create a CIM facility. "They all have to depend on each other," he adds.

Connectivity and communication challenges also exist below the MAP level. This is part of the growing trend toward a more distributed control architecture in the factory whereby more complex functions are carried out closer and closer to the factory floor. This relieves the programmable controllers from performing unnecessary tasks. Ann Courtright, director for research in the manufacturing automation division of the Yankee Group, sees distributed control as a major trend in flexible manufacturing.

In a 1986 factory automation survey conducted by the Yankee Group, 15% of the respondents indicated that they were considering using microcontrollers to replace some programmable controller functions as the link to machine sensors. Courtright believes there is a need for a generic communication bus for the level below MAP — between sensors and microcontrollers — and names Intel Corp. as a company at the forefront on the road to standardization.

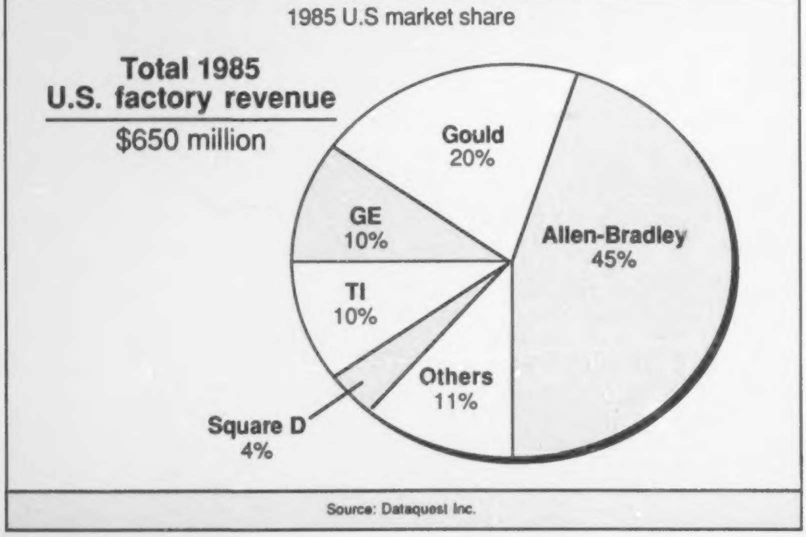
In 1984, Intel introduced the Bitbus interconnect, a serial bus that provides a standard method for connecting microcontrollers using serial communication. It is the only generic bus on the market and allows for low-cost communication across the factory floor and improves throughput, an Intel spokesperson says.

Despite its appeal, there are serious hurdles to overcome in the adoption of a standardized serial bus like Bitbus, Courtright says. The main problem is that the architecture of the factory-floor communication network is so firmly entrenched. The automotive industry, where the bulk of programmable controllers are used, will continue to use programmable controllers in the roles that they were traditionally built for, she says.

But, overcoming entrenched methods in manufacturing is the name of the game whether it is in terms of upward integration or downward integration of programmable controllers. What is clear is that without some degree of standardization, CIM will continue to be only a pipe dream.

BRUCE C.P. RAYNER

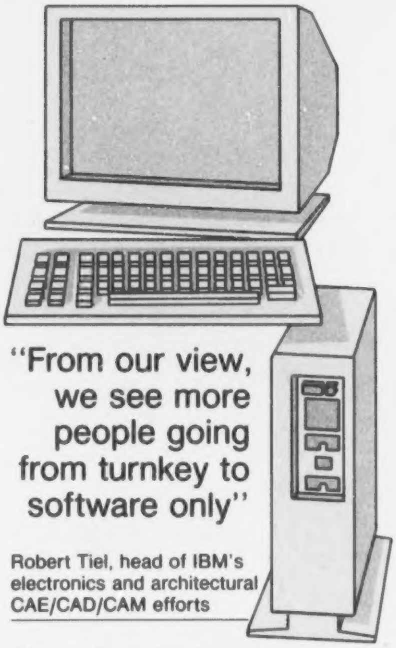
The top five programmable controller vendors



Source: Dataquest Inc.

Unrest in the CAE/CAD/CAM industry

CAE/CAD/CAM vendors are busy revamping their business plans. Reason: The market is shifting away from turnkey sales



"From our view, we see more people going from turnkey to software only"

Robert Tiel, head of IBM's electronics and architectural CAE/CAD/CAM efforts

By Alden M. Hayashi

Industries that start off as turnkey often do not stay that way. Word processing is a classic example. Although word processors were initially sold as complete turnkey systems comprised of both computer hardware and software, they are rarely sold that way today. The same thing may be happening to CAE/CAD/CAM (computer-aided engineering/design/manufacturing), systems that help users automate the design, test and manufacture of products as diverse as computer chips, airplanes and skyscrapers.

Several signs that CAE/CAD/CAM is headed away from being a turnkey business have already surfaced:

- Due to customers' demands for name-brand computers, most CAE/CAD/CAM vendors have stopped making their own proprietary computers and have instead begun using hardware from such companies as IBM and Digital Equipment Corp. (DEC). The CAE/CAD/CAM vendors buy the generic computers, combine them with homemade software and then sell the resulting systems as turnkey products. But many vendors have subsequently gone one step further by selling at least pieces of their software separate, or "unbundled" as the industry's lingo goes, from the generic hardware. Consequently, some customers have begun to buy hardware directly from the computer companies and software separately from the CAE/CAD/CAM vendors. "Unbundled software is definitely catching on," says Charles M. Foundyller, president of Daratech Inc., a market research firm located in Cambridge, Mass.
- DEC further nudged the industry away from turnkey status last year when it changed some of its discount rates and made them the same for both volume end user and CAE/CAD/CAM vendor. The action made it cheaper for certain end users to buy the hardware straight from DEC and the software unbundled from the CAE/CAD/CAM company.
- And in the low end of the market, some CAE/CAD/CAM software has turned into a commodity mail-order business.

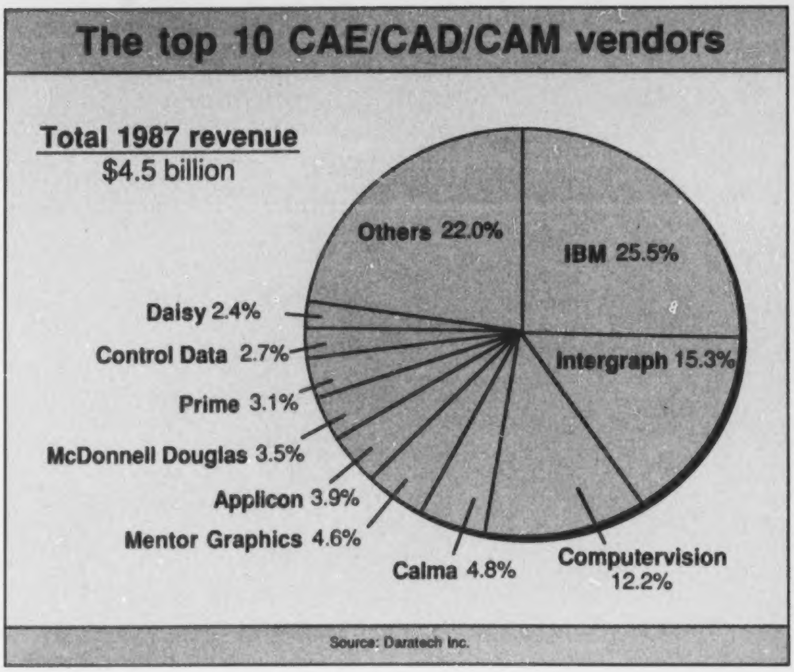
Many CAE/CAD/CAM vendors have noticed this trend away from turnkey sales and are revamping their strategies accordingly. Some companies are trying to make up for any anticipated loss in computer hardware revenue by selling more of something else. McDonnell Douglas Corp. is pushing its consulting services and proprietary value-added network. Daisy Systems Corp. sees a great future in homemade application-specific hardware that works in conjunction with the brand-name computers bought from the outside.

On the other hand, some vendors are bucking the trend. Although Computervision Corp. is now using generic computers bought from the outside, the company customizes some of the hardware so that end users must buy it from CV. Intergraph Corp. is going against the current industry wisdom that dictates using name-brand computers. The company instead is building its own proprietary workstation, forcing customers to buy the new Intergraph systems turnkey.

CV and Intergraph notwithstanding, some in the industry assert that the market's move away from turnkey sales will continue. The Technology Research Group of Boston estimates the percentage of supermicrocomputer workstations shipped turnkey in the electronics CAE/CAD/CAM market dropped from virtually 100% four years ago to 80% last year. TRG predicts the figure will plunge to 36% by 1990.

"From our view, we see more people going from turnkey to software only," says Robert P. Tiel, head of IBM's electronics and architectural/engineering/construction CAE/CAD/CAM efforts. "I think it's a reality," agrees Bill Green, manager of OEM (original equipment manufacturer) marketing for Apollo Computer Inc., a leading workstation manufacturer located in Chelmsford, Mass.

If this trend does indeed continue, it would make the CAE/CAD/CAM companies vulnerable to huge drops in sales. With Intergraph, 80% of sales are in hardware, according to president James Meadlock. Adds IBM's Tiel, "Certainly the bulk of our sales are hardware."


The top 10 CAE/CAD/CAM vendors

Source: Daratech Inc.

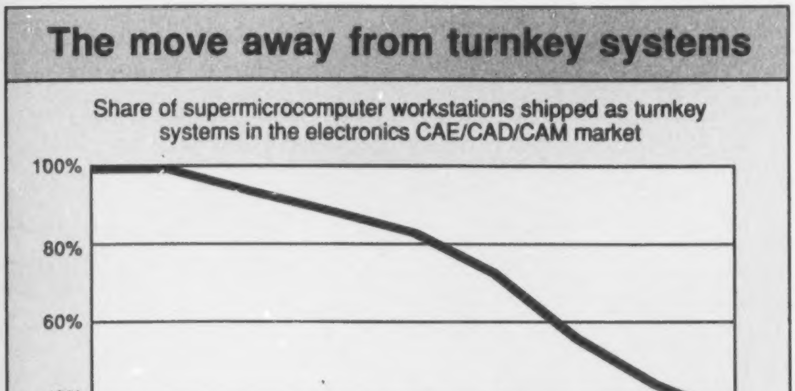
By selling both hardware and software, Intergraph and Computervision, respectively the No. 2 and No. 3 vendors in the industry, swept into the elite ranks of the *Fortune* 500. In contrast, software-only giants Cullinet Software Inc., Lotus Development Corp. and Microsoft Corp. did not. Says Intergraph's Meadlock: "I'm not terribly interested in being just a software company."

Neither is Gerard H. Langeler, executive vice president of Mentor Graphics Corp. of Beaverton, Ore. "There isn't an example of a software-only supplier in this industry that has ever been successful," notes Langeler. He explains that without the additional revenue garnered from hardware sales, research and development budgets would suffer. Bruce M. Holland, president of electronics CAE/CAD/CAM vendor Cadnetix Corp. of Boulder, Colo., agrees: "It takes enormous R&D to develop this kind of software and sometimes it's difficult maintaining the value in a software-only context." Consequently, Langeler says, "We believe very strongly that if the industry goes to software only . . . it would suffer and ultimately the customers would suffer."

Furthermore, Mentor president Thomas H. Bruggere points to another danger of becoming a software-only company. Currently, Bruggere explains, the CAE/CAD/CAM companies have control over their customers' accounts. But if they were to become exclusively software companies, they would lose that control to the hardware manufacturers, asserts Bruggere. So instead of being the first one through the customer's door, the CAE/CAD/CAM vendor would have to follow the hardware vendor, and possibly other CAE/CAD/CAM vendors, he says.

The industry's trend away from turnkey sales has caused some competitive friction between the computer manufacturers and their CAE/CAD/CAM OEMs — companies that purchase hardware from the computer manufacturers, combine it with homemade software and then sell the turnkey products to end users. Says Ray J. Thackeray, a marketing manager for DEC: "We've heard of other computer companies' sales reps trying to sell hardware to the end user in competition with the OEM." Mentor's Langeler adds, "There are certainly some large customers who, from a purchasing standpoint, want to play the hardware vendor and the CAE vendor against each other and try to get the best possible price."

Not surprisingly, the heretofore peaceful OEM symbiosis between computer manufacturer and CAE/CAD/CAM vendor has lately become strained. "There is definitely unrest out there," says Daratech's Foundyller.


The move away from turnkey systems

Source: The Technology Research Group

A love-hate relationship

DEC did not help matters when it lowered its OEM discount rates last year, making them the same for volume end users of certain computers. Clearly the change did not please Intergraph's Meadlock [ELECTRONIC BUSINESS Nov. 15 p50] who is one of DEC's largest OEMs. "We have this love-hate relationship with DEC," says Meadlock. "If we're competing for an account, . . . then we're the heavy. But if we're competing against IBM, they love us."

This love-hate relationship may have been one of the reasons Intergraph made a gutsy decision to build its own computer instead of being an OEM of DEC's workstations. Although Meadlock is discreet about the whole matter, he implies that making money by being an OEM of DEC's hardware has lately become difficult. When asked why he decided to pump valuable resources into building hardware instead of concentrating on Intergraph's strength in applications software, Meadlock replied: "Granted, it's a difficult thing to do.... . But if we didn't do it, we won't be here to talk about it next year."

DEC has since made its OEM discount rates more favorable as of last March, but many OEMs still remain wary. In various interviews, DEC president Kenneth H. Olsen has said that he is tired of OEMs getting somewhat of a free ride from computer hardware manufacturers such as DEC. But, for the record, DEC insists that it still highly values its OEM business. "All of our OEMs should be making a profit using Digital Equipment as their platform of choice. Our strategy with OEMs is, we need them and we are aggressively trying to strengthen our relationships with them," says DEC's Thackeray.

Still, actions speak louder than words and DEC's actions over the past 18 months have not been comforting to the company's OEMs. "I met with DEC recently and told them: 'I can't do business like this and survive,'" says W. Douglas Hajjar, president of Valid Logic Systems Inc., a DEC OEM located in San Jose, Calif. According to Hajjar, Valid has been losing sales to DEC. Because of lower discount rates, some customers are beginning to buy DEC hardware directly from DEC instead of through Valid, he says. "DEC is costing us probably $3 [million] to $4 million a quarter in revenue . . . . That has to change." Adds Jerry J. Robertson, marketing vice president of Applicon Inc., a DEC OEM located in Ann Arbor, Mich.: "I do believe that DEC has lost contact with its OEMs."

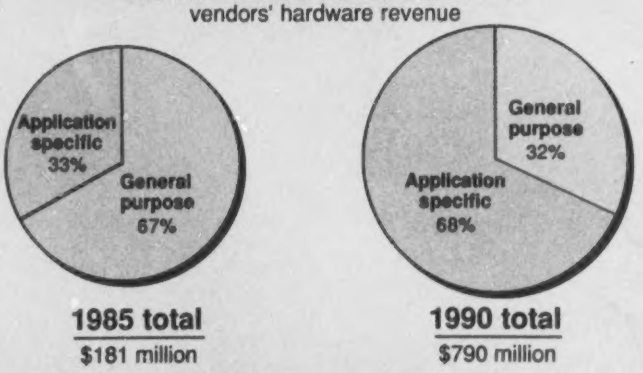
INTERGRAPH's MEADLOCK: "I'm not terribly interested in being just a software company"

Different strategies

The CAE/CAD/CAM vendors, however, have not lost contact with their market. Most of them have revamped their business plans, some in deference to the trend away from turnkey sales, some in defiance of it. "Our model is shifting now to more software. We've seen that already and our plans are in that direction," says John J. Clancy, president of the Manufacturing and Engineering Systems Co. of McDonnell Douglas, headquartered in St. Louis.

The tremendous opportunity in application-specific hardware

Distribution of electronics CAE/CAD/CAM vendors' hardware revenue



Source: The Technology Research Group

As an OEM of IBM's hardware, McDonnell Douglas has had difficulty competing against IBM's hardware salesforce. "When you start selling IBM 4300 size machines in competition with IBM, you've really got your hands full," says Clancy. According to him, McDonnell Douglas plans to make up any lost revenue in hardware sales by leveraging other products such as the company's professional consulting services and its proprietary value-added network which links an end user to its suppliers and customers.

Applicon is also currently rethinking its strategy. An OEM of DEC, IBM and Sun Microsystems Inc. hardware, Applicon is starting to unbundle its software. "The software is where we make the money. The hardware — we cover the cost. We make enough money to pay the light bill," says Robertson, marketing vice president. The company also licenses its software to other vendors, making money marginally, according to Robertson.

Daisy, of Mountain View, Calif., has also recently begun to unbundle some of its software. The company is hoping that an anticipated increase in the unit volume of software sales will offset the loss of hardware sales. According to director of marketing Robert Moore, Daisy is also counting on selling consulting services and a greater volume of application specific hardware such as accelerators and physical modelers. "There are tremendous opportunities there," he claims. TRG's market figures concur: For electronics CAE/CAD alone, the market for application-specific hardware will grow from $60 million in 1985 to $537 million in 1990.

Calma, a General Electric Co. subsidiary, sees itself turning into more of a software and services company, according to senior vice president Bruce Gregory. "One way in which we would expect our revenue to shift is toward a more effective full line of services — training, consulting, applications assistance and support," says Gregory. He claims, "Although the industry is clearly moving to a software focus, customers will continue to look for a full line of service."

Computervision is attempting a shrewd strategy to slow the industry's trend away from turnkey sales. The company, which used to build its computers from scratch, based its current generation of products on workstation hardware from Sun [ELECTRONIC BUSINESS April 1 p50] but added extra homemade graphics hardware to customize the systems. By adding the special hardware, CV does two things: it prevents end users from buying the workstations directly from Sun and it keeps CV's gross margins high.

The problem that faces CV today, according to the company's president Robert L. Gable, is how to adequately price the final product. "If we can manage our pricing structure where you get a fair price for each thing that's in there — a fair price for your hardware and a fair price for your applications software — then we will not have margin problems," he says.

Intergraph took CV's strategy one step further. By building its own workstation practically from scratch, Intergraph has completely locked its customers to turnkey sales. But Intergraph's strategy is risky: customers in the past have favored standard name-brand computers over proprietary hardware.

So Intergraph is hoping to establish its workstation as a standard in the marketplace by doing something it previously said it would not do: sell the workstation not only as a turnkey system but also as a standalone product sans software. The company is actively courting third parties, asking them to write software for the new workstation. Meadlock, however, denies that he is trying to turn Intergraph into a DEC-like computer company. "It's a marketplace that requires a different thrust than we have and a different level of distribution. . . . We are fundamentally in the application software business," he says. Nonetheless, Meadlock resolutely adds, "We are committed to continuing to be a vendor of both hardware and software."

MENTOR's LANGELER: "There isn't an example of a software-only supplier in this industry that has ever been successful"

Although the CAE/CAD/CAM industry is headed away from turnkey sales, Apollo's Green says that the trek is not inexorable. "I think it really depends more on the individual strength of the application package itself in that marketplace," he says. "Mentor Graphics has an exceptional and consistently strong solution and they are able to sell it on a turnkey basis. So I put the responsibility really on the solution supplier to make their product excellent. And if they do that, then they are entitled to every bit of margin that we provide them on a resell basis."

Indeed, Mentor (an Apollo OEM) apparently has had no trouble selling in the changing marketplace. Besides IBM and Intergraph, Mentor was the only other top 10 CAE/CAD/CAM company that was profitable last year, according to Daratech. Langeler says that although his company offers its software unbundled from the Apollo hardware, very few customers buy Mentor's products that way. Less than 5%, he claims. "We, No. 1, feel strategically its important to remain a *systems* supplier. And we think the market will buy that if we do our job right. If we don't do our job right, we deserve to have it go another way. But so far, our customers are not pushing too hard," he says.

David Card, associate editor, contributed to this article.

DEC: Friction with OEMs

". . . DEC is basically out of the OEM business and doesn't want to tell people . . ."

James Meadlock, president of Intergraph Corp., a DEC OEM

"We are not abandoning the OEM business . . . [but our] OEMs are going to have to start charging what their software is worth. . . . We are not going to [continue to] subsidize their [software] business with [deep] OEM discounts . . ."

Kenneth H. Olsen, president of Digital Equipment Corp.

Source: Daratech Inc.

Friction between DEC and its original equipment manufacturers has not gone unnoticed by DEC competitors Apollo Computer Inc., IBM and Sun Microsystems Inc. Dissatisfaction among some of DEC's OEMs provides those companies with an opportunity to move in, says Charles M. Foundyller, president of Daratech Inc., a market research firm located in Cambridge, Mass.

Speaking about IBM's dealings with its OEMs, Robert P. Tiel, head of a section of IBM's computer-aided engineering/design/manufacturing (CAE/CAD/CAM) efforts, says: "I would anticipate an improvement in that relationship." Some have already noticed one. "IBM's discounts are getting more and more aggressive," says Bill Green, OEM marketing manager for competing Apollo.

But Apollo itself has not exactly been dallying around either. The company last year embarked on an OEM recruiting program which included a more favorable discount schedule for new OEMs, a more forgiving order cancellation policy and an extended factory-warranty time period, among other incentives. The result: 75 new OEMs in 1986 alone.

"Fundamentally, I agree with Ken [Olsen of DEC]," says Green. "But I just think you have to provide OEMs a fair margin for buying your equipment in fair volume. I don't happen to agree with what DEC is doing in reducing their discounts . . . I've been in a number of meetings at Apollo lately and there is no general consideration going on right now in the company to reduce our OEM discounts." ☐

Board test meets the third wave

To the never-ending in-circuit versus functional test debate add combo testers tied to manufacturing networks

By David Card

The business of testing circuit boards is spreading out, with the high end getting higher, and the low end getting lower. This may sound obvious, but it means big changes for some of the major suppliers of automatic test equipment (ATE).

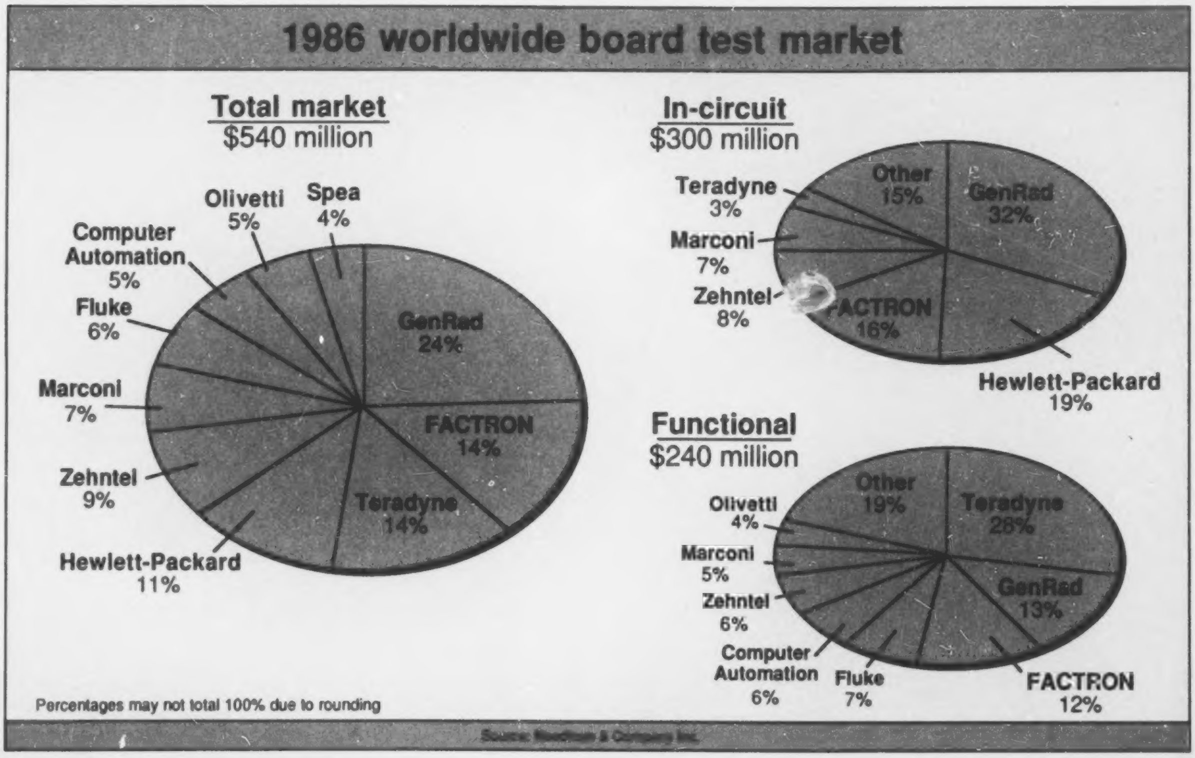
"The dominant area will be less dominant," says Kenneth Neff of market research firm Prime Data Inc. in San Jose, Calif. The majority of testers sold over the last several years employed the in-circuit method of test and cost between $100,000 and $450,000. "That middle section will wither," Neff says.

"There is a bifurcation of the traditional market," says Craig Pynn, marketing vice president of the Walnut Creek, Calif., board tester Zehntel Inc. Pynn frankly admits that Zehntel is too small a company ($10.5 million in sales in its most recent six months) to provide the emerging new spectrum of testers. Zehntel will offer low cost in-circuit testers and midrange functional models as its niche strategies, Pynn says.

In-circuit ATE tests a board by sending signals to the individual components on the board and measuring their response, on the theory that if the parts all work, the sum of them will. In-circuit testers make contact with the components through a "bed of nails" — a fixture of probes that physically connect with the contacts on the components. Functional testers plug into the board much as the board will plug into its finished system, exercising the board's functional behavior instead of its pieces. The new high-end testers, however, combine both techniques.

GenRad Inc. of Concord, Mass., is the leading supplier of in-circuit testers, commanding 32% of last year's $300 million in worldwide sales, according to New York City investment firm Needham & Company Inc. This year, GenRad is officially introducing a combinational tester, the 2750, in an assault on the high end.

In the mid-1970s, GenRad practically invented board test with its early functional models. In the early 1980s, GenRad lost the market lead in functional test to Boston-based rival Tera-


1986 worldwide board test market

Percentages may not total 100% due to rounding

Source: Needham & Company Inc.

dyne Inc. This could be the year functional sales outstrip in-circuit once again, according to GenRad estimates. GenRad executives boast that the combinational 2750 is the third technology wave in board test; Teradyne sees it as catch-up. Both intend to offer a full line of technologies, as do the two other biggest players — FACTRON/Schlumberger of Billerica, Mass., and Hewlett-Packard Co.'s Manufacturing Test Division in Loveland, Colo.

The spread

"We have to be the opposite of a niche player," says J. Robert Held, vice president and general manager of GenRad Electronic Manufacturing Test's Massachusetts Division. "The market is spreading out significantly into a wider test range." Held contends that GenRad's current in-circuit strength is stable and successful, although Hambrecht & Quist Inc. analyst Carolyn Rogers says GenRad has been losing market share steadily since 1982. GenRad has lost money for seven straight quarters.

However, analyst Rogers thinks the 2750 will be a big hit and could provide GenRad with $20 million in additional sales this year. Held says he has several systems in beta-site test situations. But Held maintains the need for a wide range of testers. "Nobody at GenRad thinks the world will shift to million-dollar testers," he says. GenRad has a scaled-down in-circuit tester, as well as a $20,000 machine aimed at the service test market. But surprisingly, Held says those will not be GenRad's answer to price-conscious manufacturing test. A new architecture is required for so-called distributed testing along factory lines. Such a machine will not be a big money maker. "We'll be offering it because we want to complete the tool kit, rather than because we're going after some exciting $80 million market," Held confesses.

According to analyst Stephen Balog at Prudential-Bache Securities Inc. in New York City: "This whole trend toward lower cost, lower cost, lower cost is bad news." He does not think the test companies can handle the shrinking gross margins.

This month, Hewlett-Packard will bring out an only slightly stripped down model of its 3065 in-circuit tester costing under $120,000. "This represents a 16% per year price erosion," says test division general manager John Scruggs. But, he contends that HP *can* manage the margins since the cost cutting comes from savings in computer technology and disk drives, courtesy of HP's computer division.

HP TEST MANAGER JOHN SCRUGGS: "I see a gradual strengthening of the market this year"

But analyst Balog continues: "The basic in-circuit market is maturing, there is no question about it. And there are a number of products around the periphery taking chunks out of it." A low-grade — and cheap — tester called a manufacturing defects analyzer (MDA) is cutting into the mainstream market, explains Prime Data's Neff. MDAs are popular in Japan, and some Japanese MDA makers are starting to show up here, Neff says. MDAs catch shorts and opens in circuit boards.

> As testing occurs more locally on the manufacturing line, the characteristics of functional testers will change
>
> Arthur Buckland of FACTRON

HP recognizes the rise of the MDA, Scruggs says, especially as capital is in such short supply these days. "Our answer at this point in time is the pricing on our in-circuit testers," Scruggs says. "The demand is real, but we're going to meet [in price] somewhere down there."

FACTRON's Japanese unit, NISSEC Ltd., makes an MDA, but is not exporting it, except to a handful of big U.S. companies, including AT&T and IBM, says Arthur Buckland, FACTRON vice president and general manager. "There are fundamental changes happening in electronics manufacturing," Buckland says, "and I don't mean surface mounting components and making them smaller. That's boring — of course everything is getting smaller." Buckland says that testing must be even more of a process control than it is, with cheaper, more localized testers feeding information back to manufacturing faster. FACTRON already sells a test system that Universal Instruments Corp., a maker of component insertion equipment, incorporates into its machines.

As testing occurs more locally on the manufacturing line, the characteristics of functional testers in particular will change, Buckland says. Database management may well be more important than technical specs, he adds.

Managing the flow

GenRad's Held could not agree more. He defines GenRad's concept of a CIM (computer-integrated manufacturing) module within a factory. A series of testers with ties to design automation systems and manufacturing would be GenRad's niche. GenRad's logic and fault simulation software is at the heart of the 2750 for the design link. Yet Held made sure the software architecture of the new testers was under the control of the team that designed its manufacturing diagnosis and analysis package.

"The last thing I want to do is say to a customer, I want to manage your factory," says Joseph Lassiter, vice president and general manager of Teradyne's Manufacturing Systems Division. Teradyne has an analysis package, but is concentrating more on the design side. It has a separate design automation division to sell its simulator. The simulator, in turn, helps to generate test programs for its functional tester.

"I've got to make sure everything connects well to the LSSD [level-sensitive scan design, an IBM technique for built-in test] and scan test [same theory, but from Digital Equipment Corp.] generators owned by companies who buy our equipment," Lassiter says. Functional testers, while more thorough than in-circuit models, are notoriously difficult to program, he admits.

But Teradyne, which is pushing the high end of functional test with its new, $3 million L290, just got into in-circuit last year. Any crossover talk is silly, Lassiter says. The reason functional testers are starting to outsell in-circuit systems is that military contractors are the traditional functional buyers, and military spending held up while the rest of electronics slumped. Anyway, he contends, it does not make any difference. "The new generation of boards won't be testable by functional or in-circuit methods, unless they're designed for testability," Lassiter says. "If they're not, there's not a damned thing I can do except maybe sell them an MDA or something."

Hewlett-Packard's Scruggs, who resells GenRad's simulator, says that simulators help in designing testable boards, but not enough. HP holds seminars and publishes guidelines for testability design. HP also has a big design automation effort. Eventually, testability could be incorporated in design software, Scruggs says, but that is a little "visionary." HP also develops fixturing kits that it sells to test service bureaus to ensure probeable boards.

> "The new generation of boards won't be testable by functional or in-circuit methods, unless they're designed for testability"
>
> **Joseph Lassiter of Teradyne**

An example

Tau-Tron Inc. illustrates some of these trends in board test. Tau-Tron is a roughly $50 million subsidiary of General Signal Corp. that makes telecommunications test equipment. Until a year ago, Westford, Massachusetts-based Tau-Tron did not use ATE, and some complex boards had an 80% failure rate by the time they reached final inspection, according to operations vice president Ted Miller. Final inspection consisted of plugging the board into a mock-up system.

Now, Miller says his Hewlett-Packard tester helps produce 85% success rates. But HP provided much more than just a $300,000 tester. HP invited Tau-Tron managers to visit HP plants to check out just-in-time delivery practices. Part of the price of the tester included HP personnel writing software to help Tau-Tron's design automation system — from Harris Corp.'s Scientific Calculations subsidiary — feed design data into the tester.

Miller does extensive diagnostics, using the tester's feedback of historical data stretching back sometimes as much as a year. "I walk right over to the printed circuit board people," Miller says, to work on manufacturing problems with the test results in hand. But what Tau-Tron likes best about the HP tester is its reliability — Miller says the machine was down for a grand total of only 14 hours in the year he has had it, including HP response time.

"The question is, 'Should we buy the next generation tester?'" Miller wonders, particularly to handle the custom chips starting to show up on Tau-Tron boards. "Right now, the answer is, no." Tau-Tron has instead gone with a vendor-certification program. Miller is willing to pay his chip suppliers up to 15% premium for them to do heavy testing, including burn-in, on new gate arrays. □

The board-test business forecast

Between them, they account for over 60% of the board test market, according to Needham & Company Inc. This is what the Big Four of board test have to say about the business outlook for the near term.

GenRad Inc.
J. Robert Held, vice president and general manager, Electronic Manufacturing Test, Massachusetts Division

"I have to say I see the market firm but flat. We certainly aren't banking on any recovery per se. Business will come back a little bit . . . it hit bottom last year." Held says that the Japanese market is very weak, suffering from the same general economics as the United States, but with the additional problems of the strong yen and no defense build-up.

FACTRON/Schlumberger
Arthur Buckland, vice president and general manager

"We anticipate 1987 to be flat. If it pops up, fine, but we're aiming to remain in control of our business rather than ramp up." Buckland expects that the demand for in-circuit testers will stay high because he does not expect most companies to change their manufacturing strategies overnight.

Teradyne Inc.
Joseph Lassiter, vice president and general manager, Manufacturing Systems Division

"Right now, ordering is not strong by any stretch. It varies by peaks and valleys quarter to quarter . . . . The only market growth comes from changes in ASP [average selling price] due to upgrades and market share growth." Lassiter says military spending props up the functional market, but that he is not worried about the Gramm-Rudman-Hollings budget balancer. "I don't think the electronics part of the military is very fearful," he says, because "missile silos and turbine blades" will be the victims of cuts. Some big projects may be in danger, "But how many boards going into SDI [the Strategic Defense Initiative] am I going to see in my lifetime?"

Hewlett-Packard Co.
John Scruggs, general manager, Manufacturing Test Division

"I see a gradual strengthening of the market this year, but I don't anticipate a boom year. In the first calendar quarter, we had double-digit growth over last year." Scruggs says new technologies such as surface-mounted components and custom chips are pushing test, rather than companies adding manufacturing capacity. He says the combinational in-circuit/functional segment is growing the fastest.

As usual, the analysts are more cheery than the participants. Raj Rajaratnam of Needham & Co. sees a 15% growth in the market this year. Kenneth Neff of Prime Data Inc. says, "It looks like it has bottomed out and it's firming up." Neff sees only 10% growth, but after a 10% and 5% market *shrink* in 1985 and 1986, that looks pretty good. After two years of financial and personnel restructuring, adds Stephen Balog of Prudential-Bache Securities Inc.: "If business does pick up, in general, companies are poised to make good money." □

Minisupers: A real market climbs toward $1 billion

The wedge between supercomputers and minicomputers is widening as sales move beyond R&D and into industrial systems

By Anne Knowles

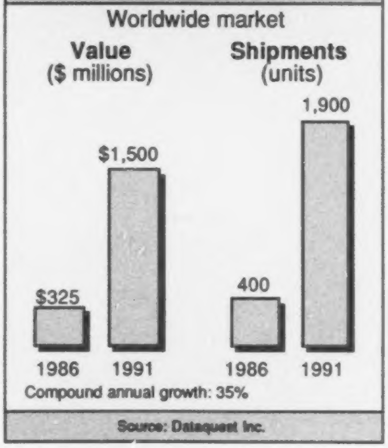
Every new computer system has its doubters. It has its proponents, too, but the skeptics are usually bigger, louder and more numerous. When IBM introduced its Personal Computer in 1981, even Big Blue questioned the PC's appeal beyond a few, select users.

The doubters are especially vociferous when new technologies, and new markets, are pioneered by new companies. When Convex Computer Corp. shipped the first minisupercomputer in March 1985, the scenario was the same. Who is Convex? What is a minisupercomputer? What market is the system designed for? Does Digital Equipment Corp. (DEC) or IBM already address that market? And, if the giants haven't noticed it yet, how viable a market can it be?

Within two years, Convex, and a handful of other start-ups, provided answers to those questions. The market for minisupers exists. And they are willing and able to accommodate it. Even DEC, the most dour doomsayer of them all, no longer disputes that. "There is a role for minisupers to play," says Michael T. Peterson, a scientist with DEC's high-performance scientific computing department. "They do satisfy niche markets."

The minisuper makers would disagree. They have a role. But the market they are after is hardly a niche. The high-performance engineering and scientific market — where minisupers are sold — is currently dominated by Cray Research Inc. and DEC. At the top are Cray supercomputers, starting at $2.5 million but typically running $15 million. A quantum jump down, in both price and performance, are DEC VAXs. In addition, there are array processors — systems that attach to superminis to provide speed for compute-intensive applications — and other speciality machines, like application accelerators.

Minisuper market is a high-growth haven



Source: Dataquest Inc.

Somewhere in the middle are minisupers, comparable in price to superminis, in the $500,000 to $1 million range, and achieving about 25% the speed of a supercomputer, manufacturers claim.

Before Convex shipped its first C1 minisuper, industry analysts were already predicting that the market for minisupers would hit $1 billion by 1990. Last year, the minisuper market more than doubled, hitting $325 million, and is now expected to grow 35% compounded annually until 1991, when it hits $1.5 billion, according to Dataquest Inc., a market research firm in San Jose, Calif.

If market projections aren't enough, company revenue bolsters the outlook. Convex recorded $40.2 million in its second year of sales. After raising $32 million in venture financing, the Richardson, Texas-based manufacturer raised another $24 million through an initial public offering made in October 1986.

Other start-ups are thriving, too. Alliant Computer Systems Corp. netted $4.5 million, on $30.8 million in sales last year, also its second year of sales. Its initial public offering raised $30 million for the Littleton, Mass., company in December 1986. Scientific Computer Systems Corp., (SCS) a privately held San Diego-based company, has sold 14 systems for an average selling price of $750,000.

And others are jumping into the fray. This April, two new contenders — Cydrome Inc. and Multiflow Computer Inc. — entered the market not only with systems but with strategic alliances. Cydrome, of Milpitas, Calif., which lists Prime Computer Corp. among its investors, also boasts of having the Natick, Mass., mini maker as its first original equipment manufacturer (OEM). Multiflow, founded in Branford, Conn., by former Yale University professors, has already set up European distribution of its product through a deal with Ing. C. Olivetti & Co.

And the market is maturing rapidly. But there have also been some market setbacks. Publicly held Flexible Computer Corp., in Dallas, recently received $3.9 million in interim financing from European venture capitalists. And Culler Scientific Systems Corp., in Goleta, Calif., had to lay off employees last year.

Already two start-ups — American Supercomputer in Sunnyvale, Calif., and the computer division of Vitesse Electronics in Camarillo, Calif., — have closed their doors. Neither was able to secure enough financing to move out of the development stage. Both companies, even their competitors claim, had stable management and promising technology.

DEC's decisions

The shakeout has begun, in part, due to the fear of impending doom. DEC's acknowledgement of the minisuper market alone verifies its authenticity. But it also raises new questions. Says Steven J. Wallach, vice president, technology at Convex: "The question asked the most is, what is DEC going to do?"

So far, DEC has responded to the market with a piecemeal strategy. In December, DEC and Floating Point Systems Inc. (FPS), the leading maker of array processors, formalized and broadened a joint-marketing deal that the two companies had had for years. DEC now bundles the VAX 8200 with FPS's M64/30 array processor and the VAX 8550 or 8700 or 8800 with the FPS M64/60. "DEC sells the whole shooting match," says Russ Doty, DEC's manager of high-performance systems.

"Cray is also working more closely with DEC to provide greater interface capability," says Jeffry Canin, an analyst with Hambrecht & Quist in San Francisco. "I wouldn't be suprised if we saw a joint-marketing agreement between Cray and DEC."

The solution provided by the FPS deal, however, already exists in the market today. The majority of FPS's processors are already installed with DEC VAXs. And the lion's share of Cray supercomputers are currently front-ended by DEC superminis. Both configurations can be, and are, accomplished independently of Cray, DEC and FPS.

The number of Cray users is also relatively small — approximately 240 supercomputers, about 160 of which are Cray machines, are installed worldwide. The market for array processors, like FPS systems, is expected to grow about 20% annually while the minisuper market could increase by 50% this year.

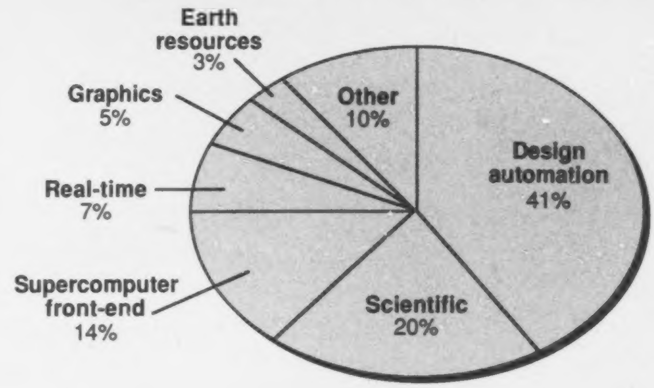
DEC, say most industry analysts, is on guard. DEC disagrees. "Digital is not on the defensive," says Peterson. "We did not enter into the FPS relationship as a defensive measure." According to DEC's Doty, when the supermini maker evaluated the market, it was decided that, "it was not feasible to bring a timely [proprietary] solution to market. The conclusion was the FPS system was the best solution today."

Today, say most observers, is the operative word. "The FPS agreement is an interim strategy until DEC gets in the market on its own," says Canin. "It doesn't make sense to go through with the FPS deal if a product was imminent," agrees Convex's Wallach.

Canin, Wallach and others expect DEC will announce a VAX system incorporating vector processing, which is competitive with minisupers, within two years. DEC's reply? "Digital for a long time has been doing advanced development work on incorporating vectors into all our computers," says Peterson. "To date, evidence suggests that from a performance standpoint we are competitive and in some cases superior [to minisupers] in raw computational power with what we have to offer today."

What minisupers will be used for in 1990

Minisupercomputer applications (share of revenue)



Source: Dataquest Inc.

Minisuper makers

DEC's announcement, if and when it comes, will have an effect on all of the players. Foremost is FPS, which stands to lose DEC's business. "FPS is aware DEC will pull out," says Hambrecht & Quist's Canin. "It gives them a two-year window of opportunity. In the meantime," says Canin, "FPS will offer greater functionality on its standalone product."

DEC's acknowledgment of the minisuper market alone verifies its authenticity

FPS claims to have originated the minisuper market with its FPS 164 array processor, introduced in 1981. Although FPS's M64 product line, sold by DEC, can be used as a standalone system, it is optimized for vector processing and not general-purpose applications. Sales of the company's array processors and its T series supercomputer, introduced last year, have been disappointing. The T series is a parallel machine, with its largest configuration currently utilizing 128 processors, based on the Transputer, a microprocessor made by Inmos. The machine was introduced running Occam, a programming language developed for the Transputer.

Last year, the Beaverton, Ore., company laid off 450 employees, changed its management after the resignation of its president, Lloyd Turner, and posted a loss of $14 million. In 1986, says Milton R. Smith, FPS chairman and chief executive, the company also "began to perceive significant competition from Convex and Alliant."

Alliant and Convex have been in the minisuper vanguard. Convex was first to market with a minisuper system, but Alliant unveiled its FX1 and FX8 systems close on Convex's heels, in July 1985. Both reached profitability within the first year of shipping product. And both went public within months of one another.

Even though it is unfair to lump the two start-ups together — due primarily to differences in their systems architecture — both companies view the market in much the same way. Convex's Wallach and Craig J. Mundie, Alliant's vice president for software product development, envision a hierarchial world of technical computing — supercomputers at the top of the pyramid, minisupers and other speciality machines at the departmental level and workstations on the engineers' or scientists' desks.

"There will always be coexistence of special purpose, large machines as servers to workstations," agrees Michael Gallup, director of product marketing at Apollo Computer Corp. With that in mind, Apollo and Alliant entered into an exclusive OEM agreement. Apollo sells the Alliant FX series internationally. Domestically, the workstation maker also sells Alliant systems, on a nonexclusive basis. "In

CONVEX's STEVEN WALLACH: "The question asked most is, what is DEC going to do?"

the U.S. there has been more of a tendency for customers to go directly to Alliant," says Gallup.

Convex, on the other hand, signed a joint-marketing deal with both Silicon Graphics Inc. and General Electric for its Graphcon workstation. And both Alliant and Convex have joint marketing and development agreements with workstation maker Sun Microsystems Inc.

Both companies joined the Network Computing Forum founded by Apollo. Both support Sun's Network File System (NFS), for distributed data sharing. And Alliant was the first vendor to license Apollo's Network Computing System (NCS), for distributed processing.

Both companies have been quick to adopt whatever standards exist currently in the marketplace. Both run a version of AT&T's Unix operating system and both provide VMS — DEC's VAX operating system — extensions to their Fortran compilers.

David L. Micciche, Alliant's vice president for marketing, sales and services, maintains that the bulk of the company's sales have not come at DEC's expense. "One-half to two-thirds of our business last year came from the area of creating market share, not taking away market share from DEC," says Micciche. But when any minisuper is purchased, it is evaluated in conjunction with a number of other systems, including DEC VAXs.

Ray Cosner, unit chief of McDonnell Douglas's propulsion laboratory, bought a dual processor C1 XP for computational fluid dynamics applications. His department also has a Cray X-MP supercomputer and a number of DEC VAX systems. Before purchasing the C1, Cosner evaluated a VAX 8600 supermini but opted for the higher performance on the C1, despite the risk of Convex's immaturity as a company.

The Analytic Sciences Corp. purchased its first Alliant system, an FX1, to replace an FPS 164 array processor and a VAX 11/780. Since then TASC has also bought a four-processor FX8 to run a multitude of applications while the FX1 is dedicated to a single problem. But TASC has also added a VAX 8200, "to have a connection to the VMS world," says Tom Stephenson, manager of TASC's advanced computing technology department.

"The vast presence of DEC is irrefutable," says Jack Hugus, Scientific Computer Systems president and chief executive. Yet SCS has depended on Cray compatibility to differentiate itself in the market. The SCS 40 runs the CTSS, Cray Time Sharing System, operating system. Announced a full year after Alliant and Convex started shipping, the SCS system had only 14 installations as of mid-April.

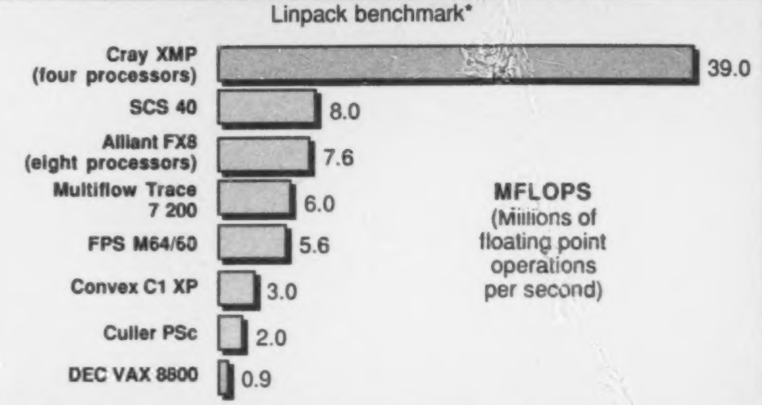
"The fact that the SCS machine ran the Cray operating system was not appealing to us," says Cyrus Cantrell, director for the center for applied optics at the University of Texas at Dallas. Despite the fact that the university uses a Cray supercomputer, the center purchased two Convex's C1 XPs. The Convex systems are utilized, in part, to write software for the Cray machine. "Cray doesn't have a workable source-level debugger," says Cantrell. Convex offered both a good debugger, says Cantrell, and "an absolutely state-of-the-art Fortran compiler."

Both Alliant and Convex have received accolades for their systems software and compilers. Alliant, in particular, has gained recognition for developing the first Fortran compiler capable of automatic parallelization.

But Convex is currently ahead in the race to provide software application packages. Both companies offer a portfolio of popular scientific and engineering packages such as Ansys, HSpice and Pisces. But Convex brought out MacNeal-Schwendler's MSC/Nastran, the most commonly used finite element analysis package, in March, while Alliant announced its intentions to port the package, which can take up to a year, in that same month. As of April, Convex had over 100 third-party software packages and is adding another 20 every quarter, according to Paul Lambert, the company's third-party product manager. Alliant, on the other hand, had 68 packages and, according to Mundie, was adding 12 to 15 packages to their catalog per quarter.

Because of its software packages,

A popular benchmark places minisupers in the middle



* The timing information presented should be in no way used to judge overall performance of a computer system since Linpack reflects one set of problems, solving dense systems of linear equations using Linpack programs in a Fortran environment.

Source: Jack Dongarra, Argonne National Laboratories says Hambrecht & Quist's Canin, "Convex is in the lead." But both companies, says Canin, must keep driving the price/perfomance leading edge to retain their market leadership in the face of other players. If the late bloomers offer substantially greater price/performance the scene could change. "Even the Convex is too slow for us," says McDonnell Douglas's Cosner. "But it's a lot better than the VAX."

And early strategic alliances — such as Cydrome's OEM arrangement with Prime — could allow any minisuper maker to gain enough volume growth to survive an eventual shakeout. That phase of the shakeout, says SCS's Hugus, will weed out the players based not on early financing or technology, but on business practices. That may be occurring now, as the minisuper makers increasingly pitch their products to industrial customers rather than research labs.

Then DEC will jump on the field. "The first thing I'll do when DEC announces," says Convex's Wallach, "is say DEC has verified what we said all along." □

What makes a minisuper run?

Minisupercomputers, for the most part, use exotic technology similar to supercomputers. Supercomputers — defined as the fastest computers available at any given time — accomplish their breakneck speeds through various features such as custom gate arrays, pipelining and vector processing. They are also optimized for numerically intensive tasks; on general-purpose applications supercomputers are failures. But on finite element analysis, no other computer comes close.

Minisupers achieve near-supercomputer performance by using much of the same technology. They are slower, however, and cheaper, because they use many off-the-shelf components and industry standard features, like the 32-bit Multibus bus structure. Each minisuper maker, working from scratch, has created a machine of a different breed. Here are some of the approaches taken by various vendors today:

Alliant Computer Systems Corp. — Alliant's FX series of minisupers can house up to eight CEs, or computational elements. The CEs are 64-bit, custom complementary metal-oxide semiconductors (CMOS) supplied by Fujitsu. Each CE has a vector instruction set, enabling it to perform vector processing. In addition, the systems have up to 12 IPs, or interactive processors, that perform input/output functions and run the operating system, Concentrix, which is a Unix 4.2BSD implementation. The IPs are based on the Motorola Inc. 68020 32-bit microprocessor.

The FX1 has one CE and the FX8 uses from two to eight CEs. If multiple CEs are used, they can perform parallel processing — working on parts of the same program independently and simultaneously — to increase speed. The company's Fortran software compiler automatically dissects and disseminates those parts of a program that can be either vectorized or parallelized. Currently, the company also has compilers for the C programming language, and Ada, the programming language of the Department of Defense, but neither performs automatic vectorization or parallelization. Alliant expects eventually to introduce automatic compilers for both C and Ada, and a Common Lisp compiler by year end. In addition, the company plans to expand its systems to incorporate more than eight CEs.

Convex Computer Corp. — Convex's C1 series closely resembles the architecture of a Cray supercomputer. It is based on 64-bit CMOS custom gate arrays from Fujitsu. In the company's low-end C1 XL, the processors have 8,000 gates; in the high-end XP, which can contain up to four processors, the processors contain 20,000 gates.

The machines are based on both vector and scalar architecture and employ RISC (reduced instruction set computer) technology, which enables the C1's instruction set to be reduced to 95 instructions. The systems also use pipelining, originated on supercomputers, which allows data to be processed in an assembly line fashion; while one instruction is being processed, another is being decoded and a third is being fetched from memory.

Convex offers Fortran and C vectorizing compilers and plans to ship an Ada compiler by 1988. In addition, the company introduced last year what it calls the Convex Extended Supercomputing Architecture. A fiber-optic or coaxial interconnect, adhering to Token Ring standards, allows the user to connect up to 240 individual devices over a network of C1 processor nodes.

Cydrome Inc. — Cydrome's system, priced in the $500,000 to $750,000 range, is a data flow type of computer. Data flow computers use numerous processors, dedicated to a specific function, rather than one central processing unit. Both proprietary, emitter coupled logic (ECL) processors and Motorola 68020 32-bit chips are used. The system runs a version of Unix System V.

Multiflow Computer Inc. — Multiflow's system is a 64-bit computer, priced between $200,000 and $1 million, that runs a version of Unix 4.3. The company developed, and patented, a software technique called Trace Scheduling. The machine also works with very long instruction words (VLIW) of 256-bit lengths. The Trace Scheduling compiler speeds up execution of both mathematical code and "junk," or scalar, code by overlapping executions. When the first execution is initiated the compiler finds the most likely route for the next execution and puts it down that path. If that route is incorrect, the operation is sent down the next most likely path and so on until the operation is completed.

Scientific Computer Systems Corp. — The SCS-40 is most like a Cray supercomputer. It is a vector-processing system that runs CTSS, Cray Time Sharing System, a Cray compatible operating system developed at Lawrence Livermore National Laboratory. Potentially, any of the 300 software applications that run on a Cray can run on an SCS-40, although, to date, the company has contracted for only a few dozen packages. The system also emulates the Cray X-MP instruction set. □

Specific memories: A $1 billion business by 1991

Application-specific memory chips have become one of the strongest semiconductor sales segments

By Valerie Rice

Memory makers can now stop singing the "commodity blues." Application-specific memories (ASMs) have arrived, bringing with them the opportunity for higher average selling prices (ASPs), new customers and applications, as well as a completely new way to look at the memory market.

ASMs are chips which combine memory with logic, creating a product that proponents say is more powerful, versatile and cost effective than logic and memory individually. Product offerings in this area include first in/first out (FIFOs) buffers, cache-tag RAMs, video RAMs and dual-port RAMs, and are available from the likes of Dallas Semiconductor, VLSI Technology Inc., Integrated Device Technology Inc. (IDT), NEC, Texas Instruments and Vitelic Corp., to name a few.

Who uses ASMs? One industry player states, categorically, that just about anyone with a microprocessor in his system is a potential customer for these products, but the market also includes telecommunications, automobiles, the military and even toys.

In fact Sun Microsystems Inc., Mountain View, Calif., uses ASMs in every single product it ships in the form of a video RAM in either color or monochrome displays. LSI Logic Corp. manufactures over 50% of its standard cell designs with memory included, up from 10% to 20% just five years ago. Even gate arrays with 20,000 gates and above are hard to find today without memory, according to LSI.

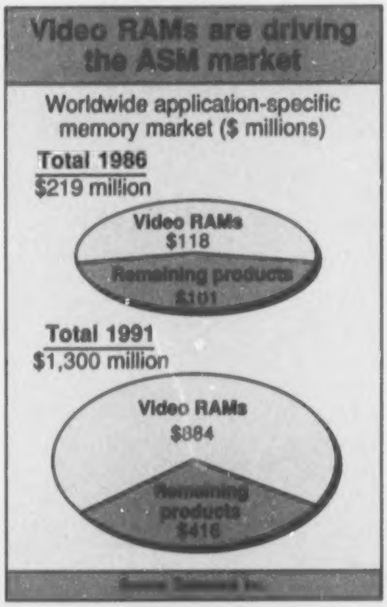
According to San Jose, California-based market research firm Dataquest Inc., specialty memories (the firm's name for ASMs) were a $219 million market in 1986 worldwide, and are predicted to grow to $1.3 billion in 1991. This is a compound annual growth rate of 42%, almost three times the growth rate of MOS memories as a whole, which will grow 15% during the same time frame.

The largest — and oldest — segment of the specialty memory market is video RAMs, which accounted for $118 million in 1986 (over half of the total market), and are forecasted to grow to $884 million in 1991, according to Dataquest.

Analysts credit two major forces in the market for the evolution and rapid growth of ASMs. The first is rapid increases in memory technology that have enabled designers to add functionality and depth to products; the second is end-user demand for faster, more cost-effective and unique solutions to their needs.

"Until two to three years ago, we were all bad memory builders," asserts LSI Logic Corp.'s new product development manager Richard Rasmussen. "Memories were big and sloppy, and putting them off the main board was much easier. Now memories are fast and have tight layouts and a reasonable price/performance ratio."

Video RAMs are driving the ASM market



Source: Dataquest Inc.

Also, until just recently, logic circuits received the bulk of the development attention while memory concentrated on process technology. In other words, says In-Stat Inc. vice president Bill Groves, the thrust was toward using less silicon and making higher density devices. "It was really a jelly bean business," he says.

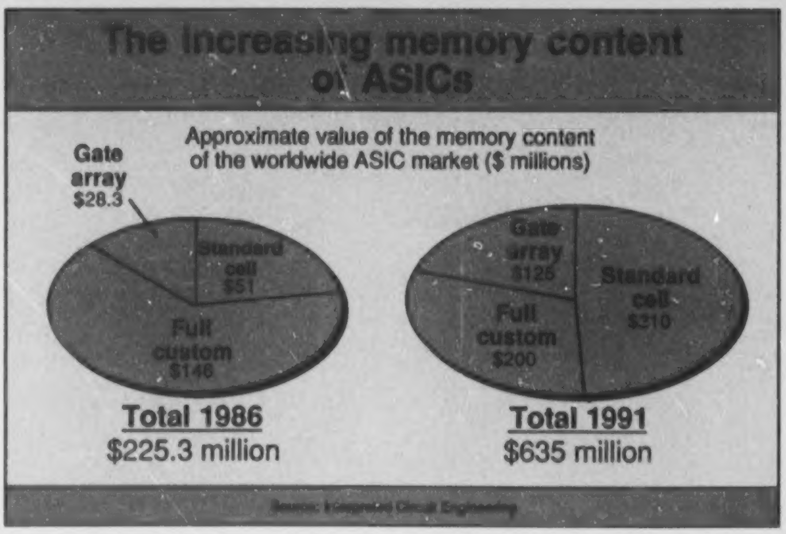
Today memory is versatile, and when a customer wants to stand out in the crowd, he can now reach for a specialty memory product. This fact, more than anything else, will help make ASMs one of the fastest growing semiconductor markets, analysts say.

Explains Vitelic's James Koo: "The customer wants to differentiate himself and needs a product to do that. A standard memory has no changes, but if you can change the memory that provides a great deal of help." Some of Vitelic's customers come to the company wanting to "revolutionize" the industry and enhance their competitive position, Koo says. By combining logic with memory, Vitelic can create a product to do just that.

"It is really an issue of performance," says Sun's engineering vice president En Bechtolsheim. "If using a cache tag allows our systems to run 10% faster, that is a chip we'll use, because it is in the critical path of the machine. The issue is how to get to a 30MHz or faster computer. The old components have too much delay."

A specific transition

Texas Instrument's Pradeep Shah, advanced product development manager for nonvolatile memories, sees the shift to ASMs as part of the industry-wide transition to application-specific integrated circuits (ASICs). Customers are cutting their number of suppliers and are demanding more responsiveness from semiconductor vendors. "What has happened in the last three to four years is a growing


The increasing memory content of ASICs

Source: Integrated Circuit Engineering

need to solve customer specific problems," he says. "We have become more customer-oriented and we want to help customers be more cost effective." Specialty memory chips, by providing users with one chip that will take the place of sometimes as many as 100 other chips, deliver users a cost and space effective solution that can give them an edge in the market, Shah says.

Users are also demanding to do things never done before, says IDT's DSP marketing manager Frank Toth. With the growing need for communications, both between systems and within various segments of the system itself, demands are being placed on semiconductors that have never before existed. "The only way to get the performance necessary is to use special memory chips," Toth says. FIFOs and dual-port RAMs, for example, have such high speed requirements that you couldn't build them any other way except on one chip, he says.

Other things have helped as well, including the dramatic growth in CAD tools, which has helped reduce the time to market for products, as well as a very real need for semiconductor companies to carve a competitive edge in the high commodity and price-sensitive memory market.

Tomorrow's commodity

However, ASMs should not be seen as a one-stop cure-all for memory woes, analysts warn. The oldest ASM, the video RAM, is practically a commodity part today, and there is tremendous competition within that market. Hitachi Corp.'s William Scharrenberg says that "one of the things we are running into is that today's ASM is tomorrow's commodity. As far as nibble mode and video RAMs: Are they ASMs or commodity? This is fast becoming a commodity market."

ASMs will also not replace standard memory parts, according to a Digital Equipment Corp. spokesman. "Our main thrust is still in the industry's standard memory areas. We do not use very many ASMs in the mainstream areas because the costs are too high. ASMs are a small piece of our overall memory usage."

In addition, ASMs are expensive, and some analysts believe that one of the largest barriers facing widespread use of ASMs is the high price point. "For use of ASMs to be really cost effective, you have to have a high volume requirement," says In-Stat's Groves. "If not, you just reach for a commodity part."

Still, ASM vendors remain optimistic and argue that as system sizes decline and the real estate within them reaches a premium, single chips that can replace large numbers of other chips with the same or faster functionality will be in high demand, regardless of the price.

Of more concern than pricing issues is the fact that much of the ASM market is populated with small companies that are breaking into the semiconductor market through niche offerings. Says VLSI ASM director and general manager Dave Handorf: "When we start seeing the Hitachis and Motorolas as competitors, we will know the market is big."

From a business standpoint, it has traditionally been the smaller players in a market which introduce a technology and take all of the risks, says market research firm Integrated Circuit Engineering's (ICE) market research manager William J. McLean. Then, when the market gets to a certain point, the larger companies step in. "If you are out with a new product every six months or so you can be one step ahead of the competition, but when you are a small company you can only do that up to a point. Once the market gets up to $300 million or so, the big companies can beat the heck out of [little companies.] Big companies let little companies break ground and design product. If it becomes a big market, they can license the technology, buy it or go into it on their own."

The head start strategy

In some cases, however, contends Dallas Semiconductor's marketing vice president Michael Bolan, first is better. "We have a two-year head start in the market," Bolan says of his cache tag and FIFO products. "It may not be so easy for large companies to take away the advantage from us." As further proof, Bolan cites Intel Corp.'s early introduction of EPROMs and its continued success in that area.

But the larger companies may have yet to really evaluate the market, Dataquest's senior industry analyst Victor DeDios believes. The smaller companies have an edge and are often the "first wave" in developing new products, he says. "We will see a wave of larger companies eventually, but everybody is still studying system applications. The smaller companies are ahead of the game in defining the market." DeDios contends that larger companies are not deterred so much by the size of the market, but by a lack of a way into the market. Once the way into the market is decided they will move.

But even ASMs are not the end of the line for memory, according to executives at Vitelic. Vitelic draws the memory "pyramid" into four segments with ASMs occupying not the top of the pyramid, as expected, but rather the high middle. Vitelic has identified a fourth memory market which executives call the customer-specific memory (CSM) market, which will provide a haven for them in case of increasing competition.

Characterizing ASMs as "off the rack tuxedos," Vitelic has labeled that next step as their custom-made tuxedos. Vitelic entered the custom business after a number of requests from customers for special memory designs. In early 1987, the CSM business became its own separate division and its plan calls for $10 million in revenue for fiscal 1988. According to marketing vice president Gary Ater, 60% of Vitelic's revenue will come from standard and ASM products this year, but next year the custom side will account for that 60%. ☐

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JULY 1, 1987

Electronic Business®

CFO survey suggests modest growth for second half of 1987

Consumer electronics: A new product blitz from Japan

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The new electronics mecca

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OUTLOOK '87
MIDYEAR UPDATE

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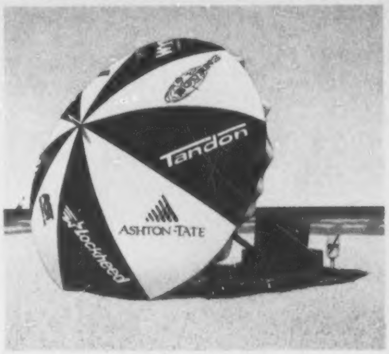

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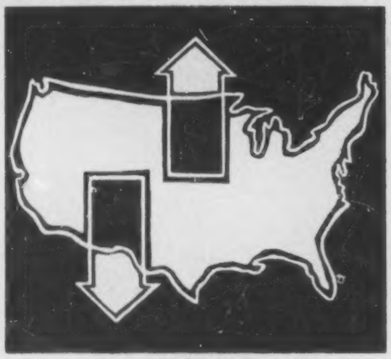

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Nursing the bottom line back to health

Chip makers should be leading the recovery. DEC was on a diet and wants to stay lean

A survey by the *Wall Street Journal* of more than 500 companies shows that their net income increased in the first quarter by 11% over the year-earlier quarter. That was no small accomplishment, in fact it was twice as good as what electronics companies managed for that quarter. The ELECTRONIC BUSINESS Index for profits, which tracks net income by a group of 16 companies we deem representative of the U.S. electronics industry, increased by 5.5%, on revenue growth of 11%.

Actually, 5.5% was nothing to be ashamed of either, especially after the profit declines of recent years. If the current forecast by Cahners economist Cheryl Patstone comes to pass, our profit index in 1987 will increase by 25% (a performance second only to 1984's) thus making up all the ground it lost in 1986, the worst year for profits in memory for the electronics industry.

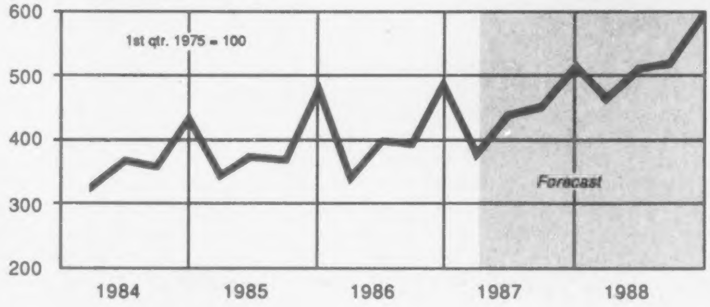
This is remarkable considering that Cahners Economics forecasts only a 10% growth in revenue for the whole year, about the same gain as in the first quarter, and shows how effective electronics companies have been at cost cutting.

Of the companies in our sample, one of the first to have reined in on costs was Digital Equipment Corp. To its credit, DEC did so long before the recession set in. Aided by successful strategies in its VAX line of departmental computers and workstations, which has swelled its revenue by 25% in the first quarter, DEC's trim operation catapulted its net income to 81% growth. "We have achieved our profit improvement over the last few years by holding down our rate of growth in costs," says vice president for finance Jim Osterhoff. DEC, as well as IBM, has held the size of its manufacturing workforce practically constant for the past five years, while most electronics companies increased employment during the 1983-84 boom and had to lay off employees or trim payrolls in 1985 and 1986. For example, reporting that Hewlett-Packard Co.'s cost of goods sold dropped in the first quarter to 46.5% of net revenue (from approximately 49% in 1985), president John Young acknowledged the contribution from the voluntary workforce reduction programs implemented in 1986.

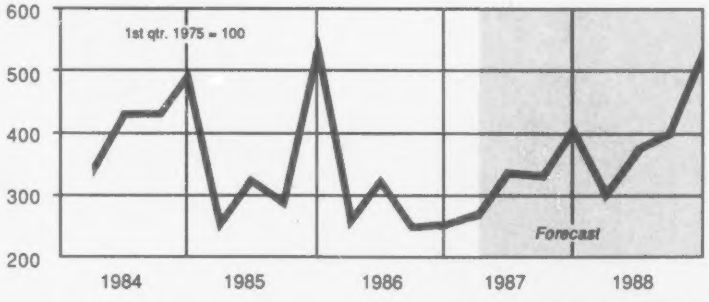
The most visible symptom of a solid recovery in 1987 is in the improving of bottom lines by semiconductor manufacturers. Intel's swung into the black in the first quarter, on a revenue gain of 41%. AMD's is still red, as its sales increased only 11%, thus matching the revenue growth by the group of companies. This has tempered the enthusiasm over the strength of this recovery because sales of components, especially semiconductors, usually lead the electronics market recovery. A healthy bottom line, therefore, will be foremost in managements' minds for 1987. "Basically, we've been on a diet," says DEC's Osterhoff. "Let's not put the fat back on. Let's stay lean and productive."

ALBERTO SOCOLOVSKY

Revenue index



Profit index



Historical data: ELECTRONIC BUSINESS
Forecast: Cahners Economics

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, has been climbing steadily since the summer of 1986. The fourth quarter was up 0.7% from the prior quarter bringing yearly production up 1%. This year, modest gains are expected to continue through midyear (first quarter production rose by 0.6%) with sharper increases in industrial production expected in the third and fourth quarters.

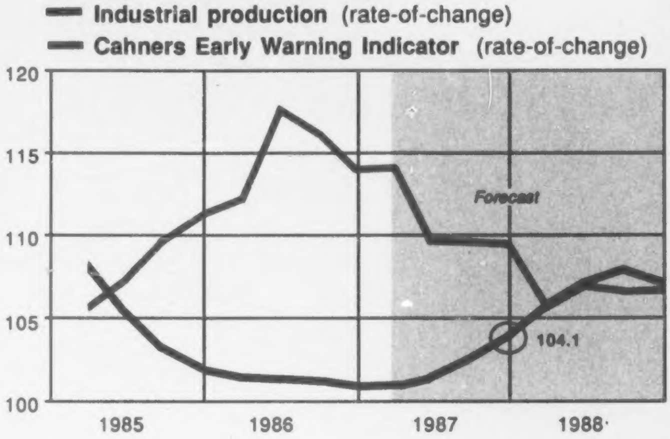
The Cahners Early Warning Indicator (CEWI) is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index. It forecasts probable business cycles about 12 months in advance. The black curve is a plot of the 12-month rate-of-change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 104.1 level forecasts using the CEWI for the end of this year indicates that the average for all of 1987 should be 4.1% above 1986.

Readers can obtain a brochure explaining the CEWI method from Cheryl Patstone, editor of the Electronic Business Forecast *newsletter, Cahners Publishing Co., 3021 Tisch Way, Suite 100, San Jose, Calif., 95128.*

ATE revenue and profit

In the final quarter of 1986, revenue for automatic test equipment manufacturers showed an 6.8% increase from the prior quarter and was up 10.6% from the year-ago quarter. The gradual improvement in the second half of the year, when demand from computer and semiconductor manufacturers for automatic test equipment showed signs of strengthening seems to signal a climate of cautious expansion. Despite this improvement in the second half of 1986, annual revenue fell 6.7% the second year in a row of declining sales (1985 revenue fell 14.4%). This year a 10.0% increase is forecast, followed by a sharp 25.8% rise in 1988. ATE manufacturers continued to rack up losses into the first quarter of 1987. A return to profitability is expected during the second half of the year.

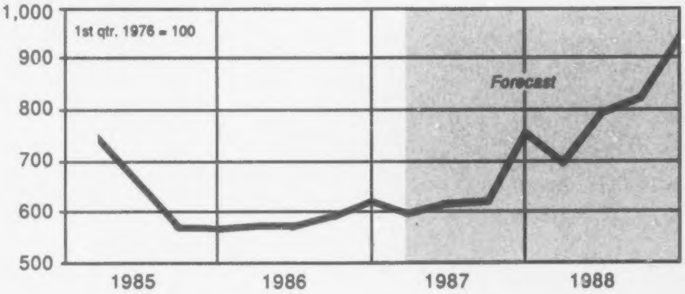
Economic indicators



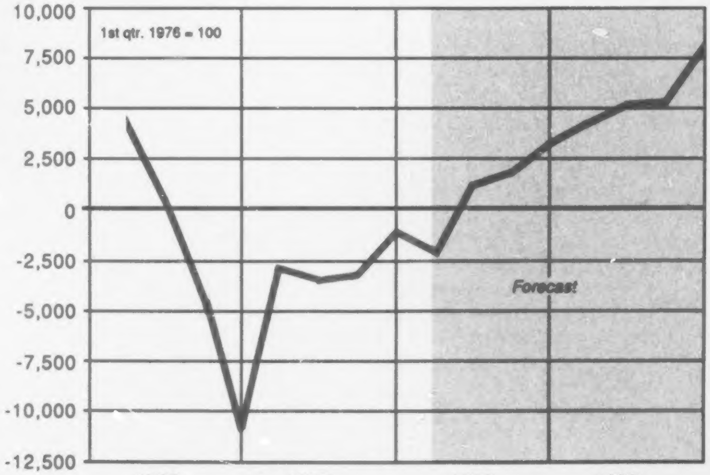
Historical data: Federal Reserve Board
Forecast: Cahners Economics

ATE indexes

Revenue



Profits



Historical data: ELECTRONIC BUSINESS
Forecast: Cahners Economics

BUSINESS BAROMETER FORECAST

Electrical machinery

(SIC 36)

	1985	1986	Forecast 1987	Forecast 1988
New orders ($ billions)	$200.35	$207.80	$217.69	$248.08
Shipments ($ billions)	$192.73	$205.61	$212.08	$234.32
Unfilled orders* ($ billions)	$90.36	$92.57	$98.18	$11.94
Inventory/shipment ratio	2.44	2.28	2.18	2.19

Historical data: U.S. Department of Commerce

Electronic components

(SIC 367)

	1985	1986	Forecast 1987	Forecast 1988
New orders ($ billions)	$40.46	$43.17	$49.20	$59.55
Shipments ($ billions)	$42.92	$44.01	$48.62	$56.62
Unfilled orders* ($ billions)	$16.47	$15.63	$16.21	$19.14
Inventory/shipment ratio	2.25	2.09	1.96	1.96

Historical data: U.S. Department of Commerce

Office and computing equipment

(SIC 357)

	1985	1986	Forecast 1987	Forecast 1988
New orders ($ billions)	$61.60	$54.32	$59.99	$74.37
Shipments ($ billions)	$62.22	$56.23	$59.22	$69.44
Unfilled orders* ($ billions)	$20.54	$18.63	19.40	24.33
Inventory/shipment ratio	2.50	2.35	2.13	2.15

Historical data: U.S. Department of Commerce

Communication equipment

(SIC 366)

	1985	1986	Forecast 1987	Forecast 1988
New orders ($ billions)	$75.97	$73.22	$71.98	$79.55
Shipments ($ billions)	$65.39	$69.73	$72.52	$77.46
Unfilled orders* ($ billions)	$65.79	$69.29	$68.75	$70.84
Inventory/shipment ratio	2.93	2.83	2.66	2.65

Historical data: U.S. Department of Commerce

Semiconductor shipments

Integrated circuit shipments

	1985	1986	Forecast 1987	Forecast 1988
U.S. market ($ billions)	$6.61	$6.93	$8.09	$10.61

Discrete semiconductor shipments

	1985	1986	Forecast 1987	Forecast 1988
U.S. market ($ billions)	$1.48	$1.58	$1.70	$2.03

Total semiconductor shipments

	1985	1986	Forecast 1987	Forecast 1988
U.S. market ($ billions)	$8.09	$8.51	$9.79	$12.65

Historical data: Semiconductor Industry Association

Industrial production

(Seasonally adjusted index, 1977 =100)

	1985	1986	Forecast 1987	Forecast 1988
Electronic components	258.1	244.1	268.4	317.4
Scientific and engineering instruments	156.6	163.2	170.8	187.1
Office and computer machines	265.4	256.6	271.0	307.6
Communication equipment	217.9	216.7	224.3	243.5
Defense and space equipment	170.7	180.3	188.8	192.4
Aircraft and parts	140.4	157.7	166.7	165.5
Total index	123.8	125.1	130.2	139.3

Historical data: Federal Reserve Board

Producer price indexes

Components (1967 = 100)

	1985	1986	Forecast 1987	Forecast 1988
Electronic components and accessories	197.9	201.5	206.6	213.7

Passive components (Dec. 1967 = 100)

	1985	1986	Forecast 1987	Forecast 1988
Capacitors	188.8	184.2	185.7	191.8
Resistors	188.7	192.4	194.6	194.9
Connectors	234.7	242.9	257.9	275.6

Active components (Dec. 1974 = 100)

	1985	1986	Forecast 1987	Forecast 1988
Digital bipolar ICs	60.4	62.4	65.0	69.5
Digital MOS ICs	35.9	32.4	32.3	33.6
Linear ICs	60.4	57.3	56.0	57.7

Historical data: Bureau of Labor Statistics

Plant utilization

(Average percentage of capacity utilized)

	1985	1986	Forecast 1987	Forecast 1988
Electrical machinery	74.7%	71.5%	72.3%	77.6%
Instruments	82.5%	80.5%	78.6%	81.7%
Aerospace	82.3%	87.7%	78.6%	81.7%

Historical data: Federal Reserve Board

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* Year-end figures

Forecasts: Cahners Economics

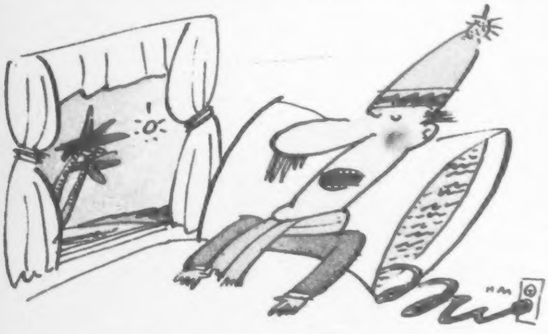
The "ELECTRONIC BUSINESS FORECAST" newsletter is available from Cheryl Patstone, Cahners Publishing Co., 3021 Tisch Way, Suite 100, San Jose, Calif. 95128

From digital audio to fiber-optic wedding dresses

What's new in the land of consumer electronics? Look for a blitz of new products in Japan

Trouble getting to sleep on hot summer nights? Try an electronically cooled pillow. Hitachi Ltd., Matsushita Electric Industrial Company Ltd. and Toshiba Corp. all have new high-tech pillows on the market that use semiconductor elements to absorb body heat, keeping the pillow several degrees cooler than the head. Retail price: around $150.

That's just one of an avalanche of new consumer electronics products to hit the Japanese market in the last few months. Japanese consumer electronics producers have had nearly two years now to come up with new strategies for coping in the world of the high yen and to start implementing them. They have been scrambling to cut costs and to come up with new, higher value-added products. And now these new products are starting to hit the marketplace.



Sleep tight! Keeping cool with microprocessor-based electronic pillows

One popular line of effort is applying electronics technology to traditional low-technology household products, like the pillow, or even the Japanese household shrine.

This high tech permeates into the kitchen also. How about waking up in the morning to freshly baked bread? Many Japanese families have an automatic rice cooker, which they set before going to bed at night to have rice ready for breakfast in the morning. An enterprising Japanese inventor has come up with a bread baker that works in much the same way. Put in flour, water and yeast before retiring, and semiconductor sensors control the rising and the baking to have the bread ready for breakfast. The entrepreneur's model will be sold under the Funai brand. Matsushita has just rushed out its own $250 version.

Then there's the fiber-optic wedding gown. The major wedding attire producer Tomita Aishoji weaves optical fibers into its top-of-the-line "Milky Way" gown, for a special twinkling effect at candlelight weddings. The company says that the bride will hardly notice the dress's built-in battery pack.

Electronic altars

Even the Japanese family's household altar has gone electronic. Japan Art Memory sells an automatic model for around $675. Clap twice and the doors on the small shrine open, the interior lights up, and a recorded prayer plays. Both Buddhist and Shinto models are available.

The consumer electronics companies are also working hard to upgrade their existing electronics products with new features to make them ever more convenient.

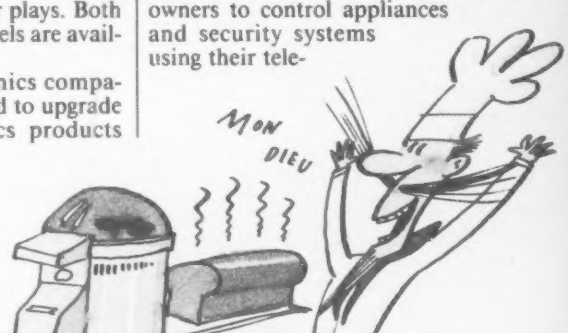
Having trouble finding a place in the kitchen to put the microwave oven? Sharp Corp. has a new refrigerator with the microwave oven built right in between the freezer and the refrigerator. Take dinner from the freezer and pop it into the microwave without moving a step. Several companies are offering new microwaves that resemble oversized casserole dishes, designed to sit on the kitchen table. Sharp also has a microwave for those who don't like programming all of those complicated numbers into the touch panel — it comes with a bar code reader that can read the bar-coded cooking instructions directly from the accompanying cookbook.

Don't like to fiddle with all those buttons on a digital watch? Citizen Watch just introduced a new voice-controlled model. Just tell it to set the alarm for seven o'clock, and it does. Or ask for the date or a phone number, and the watch displays the correct digits. Citizen expects the watch to sell for around $75.

Would you like to send a memo from your car? Mitsubishi Electric Corp. has a facsimile machine that fits under the dashboard and runs off your car battery.

Is it too much trouble to use a home computer to control the household appliances and security system? Matsushita is selling a $700 wall wiring system to developers allowing homeowners to control appliances and security systems using their tele-

Hal Mayforth



The yeast of life: Automatic breadmakers from Matsushita et al

vision screen and remote control unit.

Are you too tense from dealing with all of this gadgetry? Relax with the ultimate stereo system that delivers not only music, but also massage and oxygen-enriched air. At around $9,000, the producer thinks the system will be a little expensive for the average consumer, so it is targeting highly stressed executives. The system is made by semiconductor gas maker Japan Oxygen Inc.

Don't laugh. The Japanese consumer electronics industry may be declining, but this blitz of new products suggests that it isn't dead yet. Indeed, pressure from the high yen may have spurred a new round of innovation that will pep up demand.

"Consumer electronics trends are set in Japan these days," says Daniel Infanti, manager of corporate marketing and spokesman for Sharp Electronics Corp. in Mahwah, N.J. "And the only way to survive long term is to come up with something a little different."

"Get over here!" Watches you can talk to and watches that talk back

Although exports have plummeted, domestic Japanese sales of consumer electronics are chugging along quite nicely, thank you, largely due to the success of upgraded models. Domestic sales of color televisions were up about 8% in each of the first two quarters of 1986, compared with the same periods the previous year, according to industry association figures compiled quarterly by the industrial daily, *Nikkei Sangyo Shimbun*. Japanese sales of video tape recorders were up 18% in the first quarter, 20% in the second. Sales of stereo equipment were up about 10% in each quarter, propelled by strong demand for small compact disc (CD) component systems. Demand for Japanese language word processors, largely from consumers, was up 20% each quarter, with producers operating at 100% capacity. Not coincidentally, it was Toshiba, the market leader in these lap-top word processors, that introduced a successful lap-top computer with a readable screen in the U.S. market.

Hal Mayforth

Do you take this light bulb? A fiber-optic wedding dress — ideal for candlelit weddings

Consumer products still drive chip sales in Japan and in the rest of the world outside of the U.S.

Percentage of IC use by sector for 1986

	U.S.	Japan	Europe	Rest of world
Military	15%	—	5%	—
Industrial	12%	10%	18%	13%
Telephony	18%	18%	27%	14%
Consumer/automotive	15%	39%	30%	53%
Computer	40%	33%	20%	20%
Total ($ billions)	**$13.2**	**$11.5**	**$6.5**	**$2.7**

Includes captive production

Source: Integrated Circuit Engineering

Japanese consumers are snapping up home computers, too. Nintendo Co. claims that its inexpensive family computer has reached 30% penetration of all Japanese households, as company revenue climbed nearly 30% last year, to almost $670 million. Most of these units were purchased to play video games, but now Nintendo is coming up with new software to enable users to design and knit sweaters with a knitting machine attachment, buy and sell stocks through a network developed jointly with Nomura Securities Company Ltd., and also play exercise games where movements on a sensitive mat influence action on a computer screen.

The new product with the biggest potential market, of course, is the dig-

Ahhhhh!! A stereo system to massage you and also provide oxygen-enriched air ital audio tape player, which many hope will be the next blockbuster consumer product to reach annual sales of ¥1 trillion, or $6 million to $7 million, by the early 1990s. But some major problems must be solved first.

The first problem is price. At the initial price in Japan of around $1,200 to $1,300, Matsushita estimates all producers together will sell only about 50,000 units total this year. And prices of DAT players aren't likely to fall nearly as quickly as those of compact disc players, with the high yen squeezing margins and one digital player already in people's living rooms. "DAT will come in at a high price for the audiophile," predicts Sharp's Infanti. "With the high yen, price erosion is going to happen a lot more slowly in the future. It may be years before DAT is available for the masses."

Then there's the problem of software. Recording companies don't want to make commercial tapes for the DAT players unless there is some safety mechanism to prevent the making of perfect DAT recordings. But users don't want to buy players if there's no software to play on them. Nor do they want to buy tape recorders that won't record.

The DAT player producers are trying out a compromise solution in Japan — by making the new units able to record, but not perfectly. The DAT players now on the market use a different sampling frequency than compact disc players, so they cannot make a direct digital recording from a CD. They also contain a digital flag code recognition system, so that they can't copy commercially recorded and flag-coded digital tapes. However, the DAT players can digitally record the analog output of the digital source. Matsushita Electric Industrial officials claim that this digital-analog-digital recording is about 98% the quality of a digital-digital copy — good enough to please the audiophilea when making copies for their own use, but not good enough for pirates to use in commercially copying tapes.

The audiophile would probably be satisfied. "In the tests we did before Congress, we played a CD, a digital-analog-digital DAT recording, and a tape [that was] recorded on a high-quality analog Nakamichi Dolby C system," explains Leonard Feldman, technical consultant to the Electronic Industry Association's consumer electronics group and spokesman for the Home Recording Rights Coalition, which includes some of the major Japanese producers. "Nobody could tell the difference, including me."

But the recording industry thinks these DAT copies are too good. It wants the DAT player makers to include a copy code scanner in each machine to prevent any copying of any music containing the code, a notch of sound removed from between the notes. And it is lobbying Congress hard to get some controls put on import of the DAT players.

"DAT is not going to be as big a product as CDs," says Sharil Osgood, an analyst who tracks Japanese electronics for James Capel Securities Inc. in San Francisco. "The U.S. market depends on what action Congress takes. And homes already have CDs. People aren't going to buy both CDs and DATs. I think the Japanese market estimates of ¥1 trillion a year by 1990 are very optimistic."

PAULA DOE

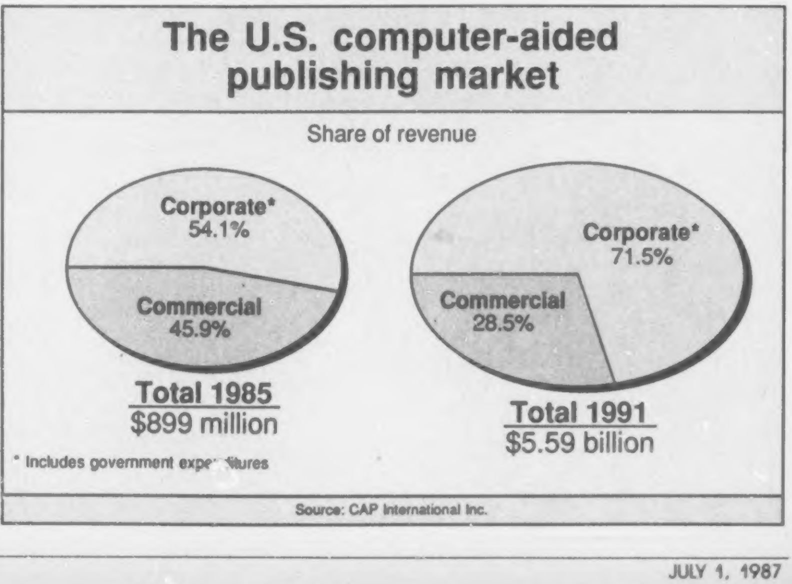
Computer-aided publishing for military applications

Mil-spec documentation systems currently represent between 20% and 30% of the electronic publishing market

There's an old saying in the military specifications business that the product isn't ready until its weight is exceeded by the documentation that supports it. Rockwell International Corp.'s B-1B bomber, for example, has a total of one million pages of documentation. And at $1,000 a page, each manual cost $1 billion to produce. A Navy ship has to carry 15 tons to 25 tons of manuals around with it.

Mil-spec documentation has always been a difficult and awkward side of the publishing business. The sheer magnitude of the preparation, revision, printing and storage of mil-spec information and repair manuals has made the defense industry a prime market for electronic publishing vendors. "It's a demanding type of publishing," says one official at Xyvision Inc., a Wakefield Mass., electronic publishing equipment company which builds high-end systems using proprietary hardware. "You don't send the jet out until the documentation is ready."

First there are the big players, Xerox Corp. and Eastman Kodak Co., which provide the large aerospace companies with specialized publishing systems ranging in cost from $250,000 to $800,000. The second tier, systems costing $50,000 to $100,000, is a highly competitive arena with several vendors using primarily minicomputing systems to sup-


The U.S. computer-aided publishing market

* Includes government expenditures

Source: CAP International Inc.

port their software. At the low end is Apple Computer Inc.'s Macintosh and Laserwriter printer, and other systems based on personal computers that can be assembled for about $10,000 to $20,000.

Just how much of the overall electronic publishing market is devoted to mil-spec applications is difficult to determine, says Kenneth Bosomworth, president of International Resource Development Inc., a Norwalk, Conn., market research firm. One of the difficulties of tracking the market is that many military vendors also produce commercial versions of their products, he says.

"If you look at the high-end systems, though, you can see that the mil-spec market is a large part of electronic publishing that the general public doesn't see," Bosomworth says. He estimates that at the high end, 20% to 30% of revenue from system sales would be attributable to military applications, he said.

The middle tier is also active in providing technical publishing systems to military equipment contractors. "Some of our biggest customers are those who do mil-spec publishing," says Michael Mark, director of special projects for Cambridge, Massachusetts-based Interleaf, which produces a publishing system that uses Sun Microsystems Inc. hardware.

The overall electronic publishing systems equipment market produced revenue of $899 million in 1985, according the CAP International Inc., a Marshfield, Mass., market research company that specializes in computer-aided publishing. The company expects that market to swell to $5.59 billion in 1991, with most of the growth occurring in sales to corporations rather than commercial printing concerns.

One of the elements driving the mil-spec market is the Defense Department's intention of completely revising its document standards and the form in which documents are published. In late summer, the DoD will release specifications for a generic text formatting code that the government hopes will bring some order to the dozens of formatting variations now on the market.

New guidelines

The Department of Defense has strict requirements as to how a manual is to be outlined. But every vendor of mil-spec publishing equipment has used different codes embedded in the text to identify the various formats and components of a document. These different "markup tags" make it difficult for the military branches to share the documentation, says Bruce Lepisto, who works for the DoD's office of the assistant secretary for production and logistics in the Weapons Support and Improvement Group. In the past, large pieces of military hardware simply came with their own computerized documentation hardware and software, he says.

Most documents are with proposals that have a long product life, according to Arlene Karsh, director of corporate publishing systems market request services for CAP International. Military equipment, such as a jet engine, could be in use for a decade or more. During that time its design could undergo dozens, if not hundreds, of modifications and updates. Each one of those must be documented in a manual and placed in the proper location. "The ability to append pages and then fold appendages into the rest of the manual is crucial," Karsh says.

New electronic publishing systems that combine graphics, text and layout will make it more feasible for military equipment vendors to bring their publishing operations in-house rather than hire outside services, says Paul Needham, director of marketing for Context Corp., a Mentor Graphics Corp. spin-off in Beaverton, Ore.

"You don't have to have complex typesetters or talented printing professionals," he says. "Everything in military publishing is fairly rigid, so you don't need a highly skilled person to design the manuals."

The demands by the DoD and defense vendors for more advanced computer publishing systems should continue as the technology advances, adds Interleaf's Mark, whose electronic publishing system is based on hardware from Apollo Computer Inc. The military is interested in read-only terminals, he says. Rather than revising a paper manual constantly, the documentation is kept on a database.

DoD's Lepisto says that the military intends to use magnetic disks, tapes and compact laser disks for storage of information on aircraft and vessels. "In a submarine, or especially on a space station, you can carry much more complete technical material than you could with paper manuals," says Lepisto. "If you took all the paper you needed for a space station, you couldn't get it off the ground," he says.

ROBERT SNOWDON JONES

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There is more to California's Southland than sun, surf and sushi. There is also a $23 billion electronics industry.

Southern California

The new electronics mecca

ABOUT THIS TIME OF YEAR, SOUTHERN CALIFORNIANS START WATERING THEIR LAWNS WITH EVEN MORE ZEST THAN USUAL. That's the signal for the Golden State's cold war to erupt in the letters pages as northern Californians lambaste the careless Los Angelenos for sprinkling away the state's precious water.

The war may be about to take a new turn because the Southland's citizens are taking away more than water. They are taking away the San Francisco Bay Area's reputation as America's technology titan.

It is news to many east of the Rockies that Southern California boasts anything more electronic than Disneyland puppets. "It hasn't grabbed attention the way Silicon Valley has," says Edward Marinaro, executive vice president of Irvine, California-based chip maker Western Digital Corp.

Yet the seven-county region, which runs from Santa Barbara, 100 miles north of Los Angeles, to the Mexican border, has quietly outpaced every other high-tech region in America in elec-

BY JOHN KERR

tronics employment, value of shipments and number of firms.

Figures produced expressly for ELECTRONIC BUSINESS by New Jersey-based commercial database Trinet Inc. reveal that Southern California's 219,200 electronics workers last year shipped $23.37 billion worth of equipment. Their 187,000 counterparts in Silicon Valley and environs sold $23.2 billion.

This suits electronics distributors just fine. According to the National Electronic Distributors Association, over 16% of the nation's $7 billion total available market is sourced from three Southern California counties: L.A., Orange and San Diego. L.A. county alone provides 7.4% of that total. Northern California, outsold by the southerners three years ago, merits less, at 14.3%.

Indeed, the lower half of the Golden State has an array of superlatives that would make any Texan eat his hat. Nowhere else is there such a concentration of aerospace and defense-electronics expertise. If the region's five central counties — L.A., Orange, Riverside, San Bernardino and Ventura — were one nation, their gross national product would be exceeded by only 13 countries worldwide.

In an unbridled rush of regional chauvinism, an economic study from the Security Pacific Corp. bank credits the Los Angeles area with the greatest concentration of mathematicians, scientists, engineers, skilled technicians and high-technology industry in the United States.

So think of Southern California as a gigantic bazaar, its myriad businesses importing and exporting more through Long Beach harbor than any other U.S. port except New York City. Its pole position on the Pacific Rim guarantees a pivotal role in development of transpacific electronics trade.

Think of it also as the western Pacific's financial powerhouse, overtaking San Francisco and challenging New York's dominance as commercial bank deposits balloon, as more overseas banks — including Japanese banks — set up shop here and as venture capital proliferates locally.

History buffs have an easy time tracing the Southland's electronics industry back to aerospace roots. Aerospace and defense electronics still symbolize the region in the way that semiconductors are the emblem of Silicon Valley. "The major impetus for this area is the defense community — it creates an incredible number of engineers," says Robert Kelley, president of Southern California Technology Executives Network, (SO/CAL/TEN), a group that convenes local chief executives to solve mutual management problems.

The defense sector also lays off incredible numbers of engineers, as Los Angelenos remember all too well. Although they won't feel a thing when the next semiconductor slump hits — Trinet's figures show only 2.6% of the region's electronics sales coming from chips — they may face tough times should the defense budget be cut further.

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Marty Braun

A talented rave

Engineering talent is what Southland electronics executives rave about when asked to list the region's electronics strengths. From San Diego to San Fernando, executives echo this comment from Bourns Inc. corporate vice president Robert McColloch: "If I were to bottom-line it, the key attraction is the pool of talent," he says. That talent, say recruiters, also tends to stay around instead of job-hopping as in Silicon Valley.

Back-to-back sunshine is, of course, a given for Southern California, and an obvious attraction. "The future of technology companies depends on young professionals; to them, quality of life is an important factor, and Southern California offers a lot of that," says Peter Shaw, president of Irvine-based workstation maker Calay Systems Inc.

The sunshine, surf and sand are on tap from Santa Barbara all the way to San Diego. The relative independence of the electronics communities in Santa Barbara and San Diego, not to mention the 200-plus miles that separate them, makes it difficult to pin a cute label on the Southland.

For years, Hollywood's wags have called the region "Tinseltown," or "LA-LA Land." In case those aren't catchy enough, the compulsive nicknamers have tried to bestow upon the area's electronics community the blessing of a memorable moniker such as "Silicon Beach," "Tri-Tech Counties," "Metroplex," even "Silicon Freeway." Mercifully, none will stick.

So in another effort to validate the amorphous high-tech agglomeration, a map of the region is being prepared, similar to the cartoon posters of Silicon Valley that decorate many a cubicle.

The area's sheer size is both a liability and an asset. "Networking" among executives is harder than up north, which is mainly why the SO/CAL/TEN group exists. But many view that as a plus because of the selective anonymity it provides. "In Silicon Valley there are no secrets," quips James Farooquee, president of peripherals maker CMS Enhancements Inc. of Tustin. Explains Western Digital's Marinaro: "You can't build any comfortable personal relationships [in Silicon Valley] because you don't know if they're going to be your competitor."

The region is as diverse as it is large. Beside the 14,000-employee aerospace plants sit tiny firms specializing in everything from factory-automation software to tape drives. Newcomers like FileNet Corp. are finding a niche in document imaging. And even the spin-offs have spin-offs: FileNet staffers left recently to form KoFax, a start-up aiming to provide generic hardware to enable standard personal computers to handle document imaging.

The chain reaction of new company formation does not appear to be as galvanic as in the Bay Area. "It's not yet what I'd call a hotbed of start-up activity," says Kipling Hagopian of Los Angeles venture financier Brentwood Associates. Although the mass is decidedly critical, observers believe that entrepreneurial zeal is dampened somewhat by the slow-moving aerospace giants.

Southland enthusiasts say that is not the case. "People have an attitude here that says: 'Let's go do it!'" says Leonard Mackenzie, chairman of computer maker General Automation Inc. There are examples to prove him right: "Gallium Gulch" is a strip of Ventura county northwest of L.A. where several gallium-arsenide specialists have spun off from Rockwell International Corp.

A diverse argument

That diversity sparks some lively dissent among local electronics chiefs: Is it a benefit or not? And does the Southland suffer from not having any core industry like semiconductor production?

The pro-diversity school insists that this difference makes the region's electronics industry more recession-proof. "There's a safety net in the diversity here," says William Conlin, president of graphics company CalComp. Adds Western Digital's Marinaro: "The beauty of it is that it doesn't have a core technology business."

But Fred Cox, longtime Southland entrepreneur and chairman of peripherals maker Emulex Corp., believes that there's a need for more silicon expertise locally because of the engineering benefits that such a basic technology imparts to related industry sectors.

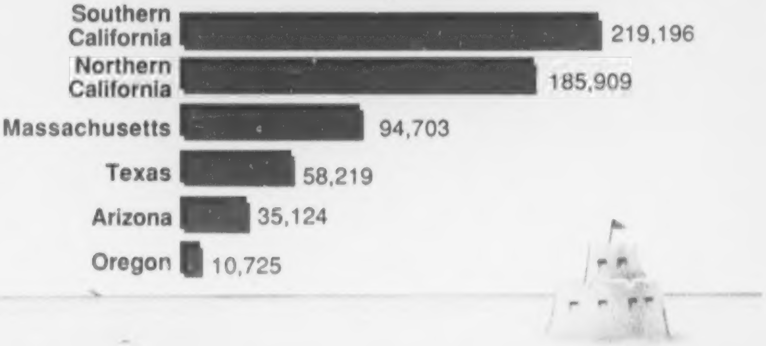
Actually, the Southland has a more solid core than many might think. Semiconductor production permeates invisibly through most of the aerospace giants like Hughes Aircraft Co. and Rockwell.

And the Orange County region could have been a minicomputer hub to rival Route 128 if firms like Computer Automation Inc. and General Automation had not been starved of management skills and venture financing in the late 1960s. "There hasn't ever been a computer company in Southern California that has made it big. There are no Apple Computers down here," says CalComp's Conlin.

Instead, the Southland fields a diverse crew of circuit-board shops, contract-assembly services, test houses, peripherals makers and systems integrators. The infrastructure is nothing if not complete: "It's tremendous — as a new start, you can get any service you want, from clean benches to printed circuit boards to component supply," says Richard Charlton,

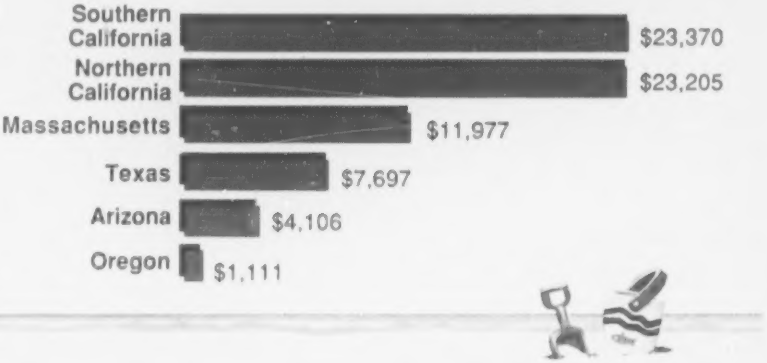
Marty Braun

Southern California has more electronics employees...



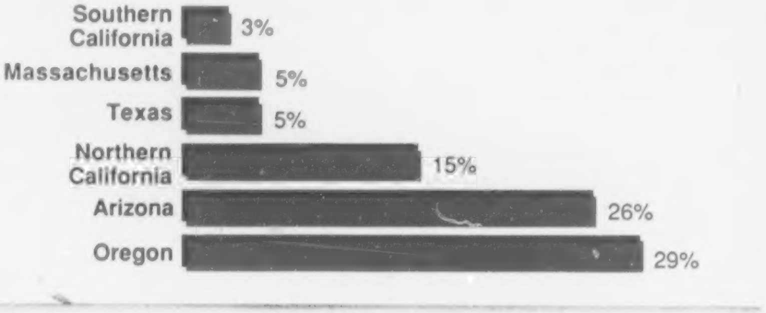
...and ships more electronics product...

($ millions)



...and is less dependent on the semiconductor industry than any other high-tech region in America

Semiconductor shipments as a percentage of total electronics shipments



Source: Trinet Inc.

founder of Irvine-based rigid-disk maker Charlton Associates, now Xidex Corp.'s Data Disc division.

In areas like Orange County, it's also easy to find factory and office space. Land developers like the Irvine Co. are tying pristine technology parks in with picturebook residential areas.

But the locale's desirability means it is a costly place to live — and thus to manufacture. Consequently, areas like Orange County focus on short-run, high value-added work with low labor content. The immigrant labor which is widespread through the region has little truck with the electronics industry; but often Southland electronics plants will off-load more labor-intensive volume assembly to majority-owned sister plants just inside the Mexican border.

And there ends the good news. Electronics executives have plenty of gripes about the Southland: its appallingly congested airports and freeways, and its smog.

More ominous is the claim of several that the region suffers from inexperienced management, particularly in marketing and finance. "I believe there's more management experience in the Bay Area. That's one of the things holding back Southern California; if there were more managers, we could move forward faster. We have more technology opportunities than managers to run with them," says Calay's Peter Shaw.

VENTURE CAPITAL

Banking on Southern California

Images of bejeweled Beverly Hills glitterati hardly foster the impression that Southern California was ever stuck for cash. But for years, the area's entrepreneurs got short shrift as venture capitalists acted as the sugar daddies of Silicon Valley and Massachusett's Route 128.

Not any more. Southern California is coming into its own as venture funds flow in and venture firms set up shop. And there is no sign of the influx slowing. "We're still seeing an awful lot of investment activity coming in," reports Jonathan Funk, general partner with InterVen Partners in Los Angeles.

Although Southern California still lags in total capital under management — about $1 billion against $5 billion-plus in the San Francisco Bay Area and more than $2.6 billion in Massachusetts, according to *Venture Capital Journal* — it had, by late 1985, absorbed as much funding that year as Route 128 and was gaining rapidly on its northern rival.

From the end of 1983 to March 1986, venture funds under management in Southern California grew 46% to $950 million. More than a dozen venture firms had formed there; another eight had opened branch offices along "The MacArthur Corridor" — the name being applied to the financial community springing up along MacArthur Boulevard, which is next to Orange County Airport. Researchers report that at least another two offices have opened since early 1986.

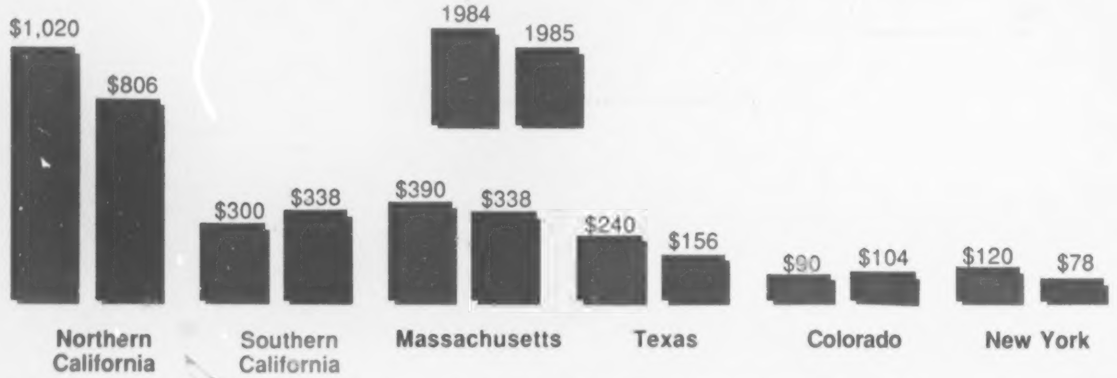
The Southland was never completely devoid of venture dollars: local money magnates like Brentwood Associates of Los Angeles had been there since 1972. Local electronics firms received some attention from Bay Area venture folks: a decade ago, printer maker Printronix Inc. of Irvine and disk-drive pioneer Tandon Corp. of Chatsworth got funding from San Francisco-based Burr, Egan, Deleage & Co.

But, generally, the region was overlooked as a second-tier market. "It's not that people were frightened of this area; more that it was perceived as the lowest priority," explains Burr, Egan, Deleage cofounder Jean Deleage.

The savvy venture firms saw dollar

Southern California gives Silicon Valley and Route 128 a run for their money

New funds invested in companies ($ millions)



Source: *Venture Capital Journal*

Marty Braun

signs in L.A. and environs precisely because it had been passed over by the crowd. "We came here because it was under-covered. There's more action up north [in Silicon Valley], but there's also more competition," explains Lawrence Lepard, a vice president of Summit Ventures, which opened a Newport Beach office in 1986.

Northern California's semiconductor slump helped accelerate the venture rush south. In the past four years, major players like Crosspoint Venture Partners and Investors In Industry have come in; in 1986, others like DSV Partners and Burr, Egan have set up local branches. DSV, with perhaps 20% of its investments in Southern California, expects its Orange County office to rival the Princeton, N.J., headquarters in strength inside two years.

Homegrown firms have opened up, too: Southern California Ventures and Julian, Cole & Stein are two such companies. Among the opportunities being targeted are medical electronics and defense.

Solid banking support is also crucial to the area's development. New York City and San Francisco were once considered America's banking hubs, but Los Angeles almost doubled its total commercial bank deposits from mid-1980 to mid-1986. With $93 billion in the vaults, L.A. trails only New York in commercial deposits, according to the Federal Deposit Insurance Corp.

Equally important to local electronics exporters is the way that Los Angeles-based banking barons like Security Pacific Corp. and First Interstate Corp. are boosting foreign-currency transactions as Pacific Rim trade grows. The region is acquiring quite a global-financing flavor: five of the 12 major Japanese banks in the United States have chosen L.A. as their corporate center. □

ORANGE COUNTY

The Orange County express

If East Coast palefaces think of Southern California high-tech at all, they usually think of Los Angeles, or at best, the San Fernando Valley to the north that is home to disk-drive firms like Tandon Corp. and Micropolis Corp.

But lately, they have been hearing more of cities like Tustin and Irvine as the electronics epicenter shifts to Orange County 40 miles south of L.A. Many may even have attended expositions at the Anaheim Convention Center next to Disneyland.

L.A.'s former bedroom community is proving anything but Mickey Mouse in industrial terms: It is fast becoming an industrial powerhouse in its own right. If the region were a separate nation, say local economists, it would rank as having the 32nd largest gross national product worldwide.

Indeed, the county is as much the polar opposite of the Rust Belt as it is possible to be. A survey of local executives conducted by University of California, Irvine, reveals irrepressible optimism: 79% predict better business for this year. The county's employment is projected to increase 5% this year, outstripping national job growth rates 2:1 and pinning unemployment to nearly 4%.

In high-tech, too, the county is putting on the ritz: Of its 50 publicly traded corporations, 15 are electronics firms with a combined stock valuation of over $1 billion. Where there once were lima-bean fields, there are now 793 electronics businesses, up from 552 in 1984.

The first invasion of the orange groves occurred in the mid-1950s as open space, cheap land and excellent transport connections made them a prime recipient of spillover from L.A.'s barnstorming aerospace industry.

The aerospace firms fostered an infrastructure of suppliers that in turn provided the underpinnings for the peripherals and computer companies that were to form there in the 1960s and 1970s.

Lately, too, Japanese companies have been locating — and relocating — in Orange County, their numbers doubling from 1979 to 1984. And local land developers have been laying out the red carpet to pull in yet more high-tech: the Irvine Co. is bulldozing 2,200 acres of agricultural land to build its showcase "Spectrum" technology park.

However, paradise is looking a little less perfect these days. A high cost of living makes for high manufacturing costs, from 5% to 20% higher than other U.S. regions, says local economist James Doti. So its electronics firms make predominantly low-volume products with high-engineering content. "It's certainly not the world's best place for manufacturing," says Fred Cox, a veteran Orange County entrepreneur and chairman of peripherals company Emulex Corp.

And in a sure sign that Orange County has come of age, electronics executives are beginning to resent a growth by-product that big-city East Coasters are all too familiar with: urban congestion. "Our airport is a disaster," grumbles one executive. □

PACIFIC RIM

The sixty-mile miracle

"The Mediterranean is the ocean of the past; the Atlantic is the ocean of the present; the Pacific is the ocean of the future."

A very contemporary theme, to be sure. But the words are those of John Hay, America's secretary of state in 1900, and his "future" lay decades away. Not until 1979 did U.S. transpacific business edge ahead of its trade across the Atlantic.

Nevertheless, bright-faced politicos are eager to push home the message that Pacific Rim trade has indeed arrived. Nowhere more so than in California, self-styled gateway to the Pacific region and the state whose electronics firms are most attuned to the transpacific possibilities.

Los Angeles gets plenty of local votes as the California region best suited to benefit. In "The Sixty-Mile Circle," a study on the economy of the area within 60 miles of its L.A. base, Security Pacific Corp. bank insists that L.A.'s the place: "In the Pacific Rim, two great urban economies stand out: the greater Los Angeles area and the greater Tokyo area. These are the leading producers of goods and services, and the leading markets. The

Pacific Basin countries are largely underdeveloped — an area with vast potential for the future. The Los Angeles area is in a very favorable position to participate in such growth."

And growth there is, say the pundits. By 1984, America's Pacific Rim trade had moved comfortably ahead of that with Europe. Researchers claim that world trade by the United States has grown from 4% of gross national product earlier this century to 17% today, and could reach 25% by the year 2000, equal to Japan's present position.

California's Department of Commerce estimates Pacific Rim trade — all imports plus exports — at over $3 trillion worth, growing at $3 billion weekly. California's portion of that came to $75 billion in 1985: $52 billion in imports, or nearly 85% of all of California's imports; and $23 billion in exports, or three-quarters of all exports (not all of these were for California-based operations, however). Japan is California's largest trading partner by far.

The increasing frenzy of Pacific freight is mirrored in predictions about the semiconductor industry. Market research firm Dataquest Inc. claims that aggregate semiconductor consumption in five key Asian markets will double by 1990, to $4 billion worth. □

SO CAL HISTORY

The Southland timeline

Where did Southern California's electronics industry come from? The answer, trite but true, is: Sunshine.

Almost every branch of the local electronics family tree is rooted in the aerospace industry which, like Hollywood's movie business, came to the L.A. basin because the weather permitted year-round production. At no time was this more critical than during World War II.

Here are a few milestones in the development of the Southland's electronics sector:

- **1938:** Howard Hughes' record breaking around the world flight confirms viability of constant radio communications between aircraft and ground stations, paves way for Hughes Aircraft Co.'s metamorphosis into defense-electronics company;

- **1942:** Arnold Beckman's new Helipot potentiometer sought by the military for use on the then-new radar; forms basis of Beckman's components business;

- **1946:** Marlan Bourns founds components maker Bourns Inc., devising for aerospace industry a linear-motion potentiometer that accurately measures minute changes in position of aircraft flight control surfaces in wind tunnel tests.

- **1947:** Hughes Aircraft Co.'s radio department becomes electronics department. Specializes in radar and guided-missile technology.

- **1950s:** Aerospace industry's supply base matures: test shops, design services and circuit-board makers grow to serve new electronics entrants.

- **1954:** Howard Hughes' thorny personality causes top Hughes staffers Simon Ramo and Dean Wooldridge to leave, form a company that was later to become TRW Inc. C.B. Thornton also departs, founds Litton Industries Inc.

- **1960s:** Orange County: Varian Data Machines, founded by ex-aerospace engineers, builds one of first minicomputers. Varian, in turn, spawns other computer companies: Computer Automation Inc., General Automation Inc. and others.

- **1973:** Computer Automation unveils Naked Mini/LSI, a low-cost minicomputer using large-scale integration.

- **1970s:** Medical electronics industry begins to grow in L.A. basin. Many firms owe origins to Beckman Instruments and Edwards Laboratories.

- **1970s:** Peripherals companies settle in Southland: Tandon Corp., Printronix Inc.

- **1980s:** Venture capital begins to flow into region.

- **1980s:** Rockwell International Corp.'s semiconductor research center northwest of L.A. is nucleus for several spin-offs making gallium arsenide chips in "Gallium Gulch." GigaBit Logic Inc. is the most famous.

- **1980s:** Japanese electronics companies now firmly entrenched in Southland. □

IVORY TOWERS

The academic brain trust

Eight years ago, a programmer at the Jet Propulsion Laboratory (JPL) in Pasadena, Calif., figured he was onto a good thing. He had devised some clever software that was perfect for running the office's football betting pool.

Few guessed how much of a good thing this program was. "Discovered" by entrepreneur George Tate, it surfaced as one of the best-known labels in desktop software: dBASE II.

The creation of Ashton-Tate's popular database package hints at the technology potential hidden inside JPL — technology that could electrify Los Angeles's high-tech base. "Just having something like JPL is of major benefit to the electronics industry in Southern California," says Intel Corp. chairman Gordon Moore.

And it raises conjecture over why the Southland's other ivory towers, the universities, have not done for local electronics firms what Bay Area academia did to fire up Silicon Valley. "We need to get more out of our universities," insists Peter Shaw, president of Irvine-based workstation maker Calay Systems Inc.

dBASE II aside, JPL's technology riches largely remained there because the NASA center had poor contacts with local industry.

For their part, the universities, until recently, lacked the breadth of technological expertise that comes from research freedom and massive funding, and which their northern counterparts, Berkeley and Stanford, enjoyed.

Not that the Southland is short of

L.A. industrialists pour praise on the ability of their universities to crank out capable engineering graduates

gray matter. Here are the jewels in the University of California crown: UCLA, UC San Diego, and UC Irvine. The area also has the prestigious California Institute of Technology (Caltech), where computer-science professor Carver Mead, now researching neural-network computers, is credited with shaping the integrated-circuit design ideas of a generation of young engineers through his textbooks.

Caltech's alumni roster is formidable: it includes Intel's Gordon Moore, venture capitalist Benjamin Rosen; instrumentation doyen Arnold Beckman; and TRW Inc. founders Simon Ramo and Dean Wooldridge.

But what Southland academia lacked in available core technology, they have more than made up for in other ways. L.A. industrialists pour praise on the ability of their universities to crank out capable engineering graduates.

Interstate Electronics Corp. can testify to that: the defense contractor used to recruit engineers nationwide, but now, says president Richard Foster, he gets the talent he needs locally. Over half the recruiters that visit Caltech are from California corporations.

The local schools also provide business-school backing. Pepperdine University and UCLA's graduate school of business offer middle management the training to climb the corporate ladder.

Regarding the universities' technology lag: Calay's Shaw will be heartened to learn that Southland campuses are less wet behind the ears these days. UCI now wins plaudits for its computer-science school. And they are actively trying to transfer their technology to industry. At UC Santa Barbara, a $14 million semiconductor-manufacturing program is assisting local defense contractor Delco Systems Operations and others, while a smaller effort on exotic semiconductor compounds is receiving Semiconductor Research Corp. funds.

To the south, UC Irvine's corporate university partners program is beginning to draw industry attention in medical electronics. CalTech has a technology-transfer scheme that allows industry-consortium members to steer and benefit from research into solid-state physics and other fundamental sciences.

And JPL has finally found a middleman. Last year, the RIMTech networking group launched a technology-transfer program that promises to sell Southland electronics participants JPL's skills in everything from error-correcting codes to advanced graphics. ☐

DEFENSE

A defensive reliance

Los Angelenos who still thrill to The Beach Boys remember the post-Vietnam slowdown in the aerospace industry that laid off many local engineers. No one wants it to happen again.

However, the signs are that Southern California is still substantially dependent on the fortunes of the defense sector. Just how dependent is hard to tell: California's Department of Commerce says that over half a million residents work in defense in the six coastal counties from Santa Barbara south to San Diego. The "Top 400," a guide to Orange County's electronics companies, indicates that a third of that county's employment is in aerospace and defense.

"We certainly are more vulnerable to a defense downturn than the Bay Area or Route 128. I'd bet that well over half [of the Southland's electronics] employees are aerospace and defense oriented," says Richard Foster, president of Anaheim contractor Interstate Electronics Corp.

But others believe Southern California's economy is more immune to defense cutbacks than in 1971, largely because of the dramatic buildup in other electronics sectors.

Electronics distributors that supply military contractors are unequivocal. "The strength of the market here has been and continues to be defense," says Ralph Ozorkiewicz, president of Wyle Laboratories' Electronics Marketing Group. He estimates that about 30% of Southern California's total available market is in military work.

That work ranges from Rockwell International Corp.'s production of the B-1B bomber to the infrared missile-guidance systems built by Ford Aerospace & Communications Corp. and used in last year's U.S. raid on Libya; from classified research on Stealth technology at Northrop Corp. to development of blue-green lasers and gallium-arsenide chips at Hughes Aircraft Co.

The region has landed some plum programs: the $65 billion development of the Advanced Technology Fighter (ATF), now being competed for between prime contractors Northrop and Lockheed Corp. The *Los Angeles Times* claims that as many as half of the subcontractors, which should receive up to 75% of ATF revenue, are in Southern California.

However, a distinct industry downturn is already under way. Market research firm Henderson Ventures of Los Altos, Calif., puts a 3.6% growth rate on military electronics production in 1988; most believe zero real growth is more like it. Major contractors like Hughes have put workforce reductions in place — a 5% cut from its 80,000 level. Fortunately for the Southland, it has not yet felt the squeeze.

Several local electronics executives point to substantial benefits either way. "When aerospace softens, it loosens up the labor pool," explains Peter Shaw, president of Calay Systems Inc., an Irvine-based producer of work-

Southern California's economy is more immune to defense cutbacks than in 1971, largely because of the dramatic buildup in other electronics sectors

Marty Braun

stations for circuit-board design. If the downturn becomes serious, L.A.'s electronics employers can get choosy: aerospace firms hire and fire in the thousands.

They may be well worth hiring, but do these engineers have what it takes to start their own companies? Unlikely, say most observers: Aerospace types may design superlative microwidgets, but they typically lack the right stuff: the entrepreneurial thrust and management talent that fuel high-tech start-ups. "It's not the kind of industry that lends itself to start-ups," says one venture capitalist.

Nevertheless, some of his fellows are intent on finding the exceptions that prove the rule. James Julian, a partner with Julian, Cole & Stein in L.A., aims to tap the aerospace industry and back engineering brilliance with street-smart management. "Aerospace is one of the last bastions of great technology," he maintains. ☐

JAPANESE PRESENCE

The Japanese connection

Heading east from Los Angeles International airport on Route 91, a visitor could be forgiven for thinking he had missed L.A. altogether and landed in Tokyo. A profusion of Nippon names is the roadside greeting thereabouts.

A concentration of Japanese industrials is not peculiar to Southern California, but the density of that agglomeration and the speed with which it has grown are unusual. The Japan Business Association of Southern California has 550 corporate members, 65 of them electronics and electrical; in 1962, it had 58 members, none of which were in electronics.

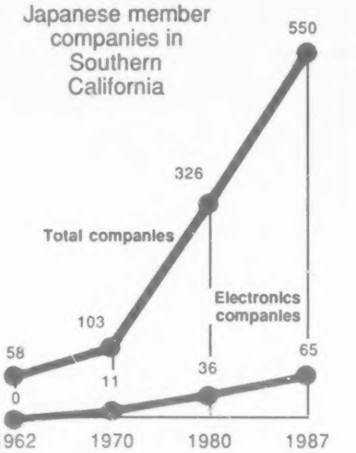
California's technology reputation and its large business and consumer markets have long made the Golden State a favorite for Japan's industrial investors. The Pacific time zone is handy too: a late-afternoon phone call catches the Land of the Rising Sun not long after the sun has risen.

No surprise, then, that Japan is the largest foreign employer in California and that the state accounts for 25% of the value of Japanese property in the United States. California's Department of Commerce calculates that the value of property, plants and equipment owned by Japanese companies in California climbed sevenfold from 1977 to $3.8 billion in 1984, with about one-sixth of that in electrical and electronics machinery.

The Japanese show a marked preference for the state's southern half. In 1985, they made 54 investments in the greater L.A. area against 34 in the Bay Area. Reports indicate that 800 of the state's 1,000 Japanese companies are in the south, and that of the 12 major Japanese banks in the United States, five are based in Los Angeles.

The phenomenon owes just as much to cultural links and L.A.'s acceptance of ethnic diversity as to its Pacific proximity. "L.A. was certainly the city where the first Japanese immigrants came," says Takeshi Sakurai, president of Mitsubishi Electronics America Inc.

The Japanese presence is expanding fast in Southern California



Source: Japan Business Association of Southern California

Those immigrants arrived over a century ago, helping build the transcontinental railroad and later moving into farming and produce marketing. Around a "Little Tokyo" in downtown Los Angeles, they set up schools, restaurants and other cultural anchors that have since proved a draw for incoming Japanese industrialists. Torrance-based Seiko Instruments USA Inc. president Hiroshi Fukino is pleased that his daughters can attend Saturday school nearby.

Within the L.A. basin, many of the Japanese electronics concerns settled initially in Torrance and Compton, near Los Angeles International airport, Long Beach harbor and the Japanese banks. But lately there has been a shift south into Orange County, a trend Mitsubishi's Sakurai says he attributes to the wealth of "good engineers" in the area.

The Japanese have also put down manufacturing roots, more often to ease dollar-yen fluctuations than for betterment of trade relations. Mitsubishi recently escaped trade tariffs on its personal computers because it assembles in Torrance. Hitachi Ltd. builds the only American-made video cassette recorders in Anaheim. ☐

MEXICO

South of Southland's border

Southern California has an electronics ace that only Texas can match: its proximity to Mexico. More than a few Los Angeles-based electronics companies owe their financial health to the nearness of the border.

Local electronics employers do not benefit from the influx of day workers from Mexico to "El Norte," nor from the base of immigrant labor in the Southland. Their edge comes instead from the *maquiladoras* — subsidiaries they own south of the border.

The so-called maquilas import parts from the U.S. duty free and "export" assembled units back to the States with 10% average value-added tax, giving U.S. firms the blessings of offshore manufacturing with fewer of the drawbacks.

As a rule, Southern California's electronics companies have benefited more than any others from these Mexican subsidiaries. "You don't have a lot of representation from Silicon Valley," says John Sartori, president of Sarco International, a Newport Beach-based consultancy specializing in border manufacturing services.

"There are clearly more Southern California firms that have more knowledge of maquilas, and with more knowledge comes more involvement," adds Gordon Reed, a vice president of Santa Ana, Calif., manu-

Marty Braun

facturing engineering consultancy North & Donahoe.

Sartori says that of the 1,100 maquilas along the border nearly 40% are in Baja California, California's Mexican neighbor. Of these, up to 60% are affiliated with Southern California concerns, with a strong bias toward electronics assembly.

Among the L.A.-basin electronics companies with large maquilas are: Hughes Aircraft Co., passive components maker Bourns Inc., power semiconductor producer International Rectifier Corp. (IR), disk-drive builder Shugart Corp. and Rockwell International Corp.'s Semiconductor Products Division (SPD).

Rockwell's Newport Beach, California-based SPD has plenty of praise for the yields, costs and cycle times of the Mexican sister plant it first opened in 1969 and which it upgraded last year into a full metal-oxide semiconductor assembly and testing plant. Admits Gerry Gross, director of device manufacturing: "Had we not done that, we would not have been competitive. We would have lost money."

Mexican plants offer freedom from the product piracy that plagues Far Eastern facilities

IR has had an assembly maquila for its high-power Schottky diodes for a decade. "We have been profitable during the five to eight years that others were not. To a fairly high degree that is due to our Tijuana plant," says Anders Nilarp, worldwide vice president for high-power operations.

And Information Magnetics Corp., the division of CCT Corp. that makes magnetic heads for fixed disk drives, moved its headquarters to San Diego to be closer to the maquila it credits with countering Far East competition.

Low labor costs are an obvious plus for the maquilas: Sarco International prices their average electronics assembly labor at less than $1 per hour with all fringes. Overall return on assets is high: IR's Nilarp maintains that a similar plant located in the Far East would have to carry up to three times the parts inventory. Other gains include energy costs that are nearly a quarter of those north of the border, and less stifling factory regulations.

Consultant Gordon Reed adds that Mexican plants offer freedom from the product piracy that plagues Far Eastern facilities. And experts point to the ease with which the maquilas can be overseen from Southern California: Tijuana is a two-hour drive from Los Angeles; Mexicali and Nogales are not much further.

But these advantages have not been enough to outweigh one sharp drawback discovered by printer maker Printronix Inc. of Irvine. Hurt by the difficulty of sourcing components for its Mexicali facility and by the dearth of electronics professionals locally, Printronix recently shut the plant down and moved instead to Singapore. ☐

MEDICAL ELECTRONICS

Med-Tech in the sun

Pinning an industrial identity on Southern California is like trying to nail jello to the ceiling. Unlike the San Francisco Bay Area's synonymity with semiconductors, L.A.'s eclectic electronics mix does not make for easy labeling.

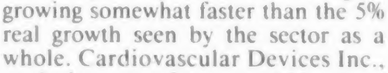
But there is one sector that is starting to call the region home: medical electronics. With Orange County as its hub, a mini-industry, making products from heart pacemaker chips to controllers for intravenous fluid delivery, is laying claim to the third-ranked spot for production of medical-electronics equipment in the United States. It has even earned itself a nickname: "Med-Tech."

According to Tustin, California-based journal *Biomedical Business International*, Southern California's microchip medicos number about 60, up 50% in five years. Their aggregrate revenue tops $500 million annually; New England leads, with up to $800 million, with Minneapolis — a center of pacemaker production — in second place.

Med-Tech, whose specialties include diagnostic imaging, clinical chemistry and patient monitoring, is growing somewhat faster than the 5% real growth seen by the sector as a whole. Cardiovascular Devices Inc., an Irvine manufacturer of blood-gas monitors for open-heart surgery, expects over 25% annual pick up.

But the Orange County region, say proponents, is set for greater things because it is moving swiftly into new technologies. There is promise for analog-to-digital chip technology, which is enabling custom-chip suppliers like Holt Integrated Circuits Inc. of Irvine to shed reliance on pacemaker chip sales and enter instrumentation markets with new products like its single-chip pH meter.

The Orange County region, say proponents, is set for greater things because it is moving swiftly into new technologies



Marty Braun

Similarly, Tustin-based Silicon Systems Inc., a maker of chips for modems and disk-drive controllers, is close to a program to develop biosensor chips whose analog function will "read' biological conditions and transmit them to the digital portion of the same sliver of silicon for data processing.

The Southland's medical-electronics skills were honed in unwitting nuclei like Beckman Instruments Inc. and Edwards Laboratories, and grew without much early support from local schools. But now, campuses like University of California, San Diego and University of California, Irvine (UCI) promise strong back-up. UCI's 3-year-old corporate partners program is starting to push medical technology out of its labs and into local industry.

Silicon Systems has signed up; Holt is keen to. "Industry wants to use us as a think tank," explains Daniel Morris, manager of UCI's partnership scheme. UCI's laboratories have already been useful to Irvine-based Trimedyne Inc., a $10 million company making a laser device for clearing clogged arteries. ☐

CFOs remain cautious about the economy

An exclusive ELECTRONIC BUSINESS poll of 127 chief financial officers suggests modest growth in the second half

By Bruce C.P. Rayner and Nancy McSharry

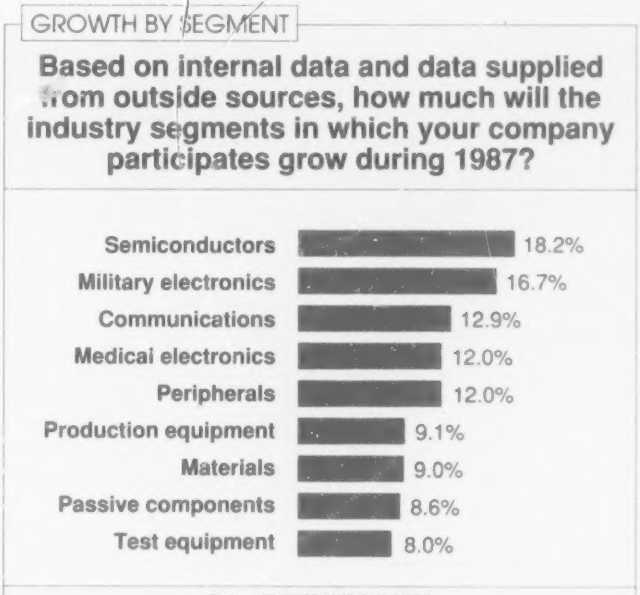
The electronics industry will undergo modest growth for the remainder of the year, according to the ELECTRONIC BUSINESS midyear survey of chief financial officers and vice presidents for finance. One of the biggest concerns is the growing uncertainty surrounding the trade friction with Japan.

But first the good news. For the second half of 1987, CFOs expect growth rates in segments of the electronics industry to range from 8.6% in passive components to a healthy 18% for semiconductor makers. Putting these figures in context, Data Resources Inc. (DRI), a leading economic forecasting firm based in Lexington, Mass., expects U.S. GNP growth of a meager 3% annual rate for the second half of the year.

Another bright spot gleaned from the survey is that 60% of the respondents expect their factory utilization to increase during the next two quarters. This is partly due to short-term market improvements combined with a glimmer of hope for U.S. export growth, especially in Europe. Over 50% of respondents expect the European computer and electronics market to expand as the weaker dollar begins to generate demand. Also, over 40% of those surveyed indicated that they will increase their rate of capital and R&D investment in the second half of 1987, compared with the same period in 1986.

The ELECTRONIC BUSINESS survey results are based on a comprehensive questionnaire mailed to 700 financial officers in the U.S. electronics industry. In all, 127 completed questionnaires were returned, representing an 18% response rate. Over 51% of the companies polled had revenue of less than $20 million for 1986. We believe the survey is 97% accurate, with a margin of error of plus or minus 3%.

Nevertheless, expected growth rates in factory utilization and capital expenditure forecast by our respondents may be misleading. Both figures were low last year, so increases do not necessarily mean substantial economic improvements. For instance, capital spending in the first quarter of 1987 was uncharacteristically low partly because of tax reform: specifically, changes in depreciation methods and the repeal of the investment tax credit. So, even though the rate of capital spending is improving, it is still far from robust. David Wyss, senior vice president at DRI, forecasts that equipment investment will grow at a rate of 5.5% to 6% for the remainder of the year.



Source: ELECTRONIC BUSINESS

For the second half of 1987, 50.7% of the respondents expect the European computer and electronics market to expand. Also, 47.6% characterize the military equipment market as "good" and 45.3% expect military spending on electronics to rise over the next two years. But prices are on the up and up: 66.9% believe U.S. labor costs will rise over the next two years; 82.3% see inflation rising over the next six months; and 66.9% expect the price of precious metals to rise in the second half of the year.

Underlying issues

Most of the news from chief financial officers is of a more somber tone. There are some underlying economic issues that are stifling true recovery, many financial officers believe. The list of complaints is lengthy: inflation and interest rates are on the rise, the dollar is weak and possibly weakening further (a mixed blessing), the national debt grows daily and trade friction has everyone on edge. "Taken in the aggregate," says Timothy Carlson, vice president for finance of Laserpath Inc., a $3 million gate array semiconductor manufacturer in Sunnyvale, Calif., "that's a picture that is of some concern." Carlson expects some economic hiccups before the year is out. Others agree with his prognosis.

Most economists agree that a weak dollar is beginning to reverse the U.S. trade deficit. But because many Far Eastern countries tie their currencies to the U.S. dollar — these include South Korea, Singapore and Taiwan — the effect on imports is not consistent. It is mainly the Japanese yen and European currencies that have continued to rise against the dollar. Some believe the current yen exchange rate — around 140 yen to the dollar — could still drop 15% before it bottoms out. Wyss estimates the dollar's value will reach a low of ¥120, but probably not until next year.

Still, in the last quarter of 1986 and the first quarter of 1987, the volume of U.S. imports declined, while exports grew at a 14% rate for the second half of 1986, says Wyss. He predicts that U.S. exports will grow in the second half of 1987 but not quite as rapidly. Despite the fact that import prices continue to rise, he says there is a clear trend toward the United States buying fewer foreign goods, especially Japanese products. The reason — says John Rogers, vice president for finance and company treasurer at Zytec Corp., a $50 million power supply maker in Eden Prairie, Minn. — is that the price advantage that Japan has had over the United States is eroding. In the past year, it has dropped from around a 15% differential to only 5%, Rogers says.

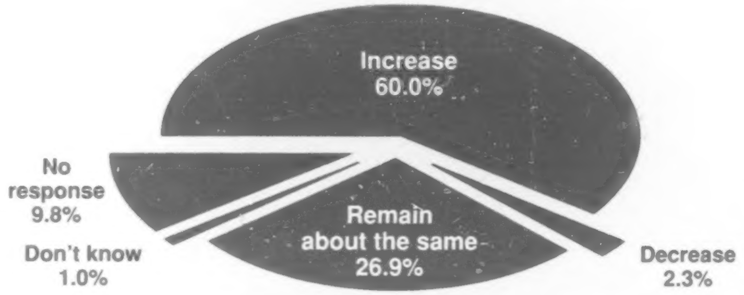
Robert Golden, vice president for finance at Cleveland-based Mueller Electric Co., a $5 million supplier of electrical test clips and test leads, agrees that the falling dollar is starting to take hold. He says that his domestic customers are beginning to increase their exports, while Mueller is seeing a pickup in its Canadian and European orders.

Rising prices

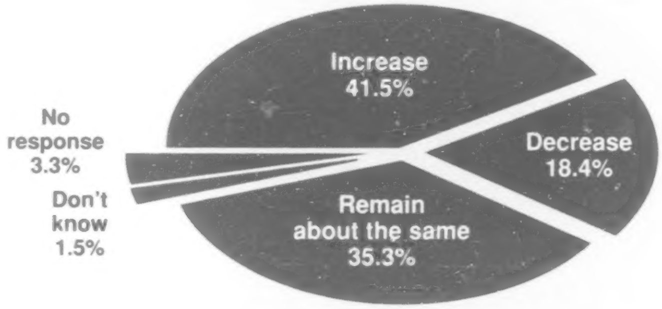
At the same time, there are negative consequences of a weak dollar that must be considered. The most notable side effect is the increasing price of foreign components that U.S. electronics manufacturers are forced to pay. Gene Ruckh, chief financial officer of Computer Communications Inc. (CCI), a $10 million Torrance, California-based maker of transactional processing systems, says that costs of Japanese commodity chips are rising and availability could become an issue. CCI gets about 20% of

PRODUCTION AND INVESTMENT

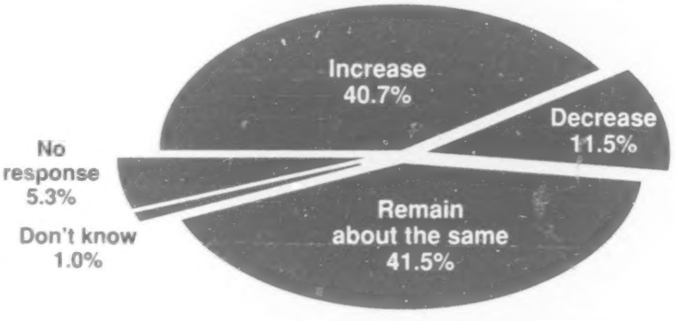
In the second half of 1987, will factory utilization for your company:



In comparing the second half of 1987 with the same period of 1986, do you expect your company's rate of capital investment to:



In comparing the second half of 1987 with the year-earlier period, do you expect your company's rate of R&D investment to:



Source: ELECTRONIC BUSINESS

Only 29.9% of those respondents expect to add manufacturing capacity and only 34.6% will find it necessary to raise capital in the second half of 1987. Part of the reason for holding off on adding factory space may have to do with the expectation of increasing interest rates: 74.6% expect interest rates to rise. More likely, however, it has to do with the low level of plant utilization during 1986 and the first half of 1987. Similarly, capital expenditure, in the form of purchases of equipment, has been very depressed for the last year largely as a result of conditions in the industry but also because of tax reform.

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its materials from offshore. Ruckh speculates that Japan will begin to shift production offshore to a second-country surrogate, such as South Korea, in order to keep prices under control and hold onto its U.S. market share.

But more threatening to American companies than rising prices of materials is the fact that U.S. companies are now considered good value in the eyes of foreigners who are looking for acquisitions in the United States. Over 28% of those surveyed say that they expect foreign corporations to increase the rate of acquisition of U.S. firms, while 35% indicated the rate would remain about the same.

Direct investment in U.S. companies by the Japanese is also a way of deflecting protectionist measures that Congress might impose in the near future. Joint ventures, start-ups and buyouts are all options that Japanese companies are looking at. Also, there has been a noticeable shift by the Japanese from the bond market into the stock market since last year, says DRI's Wyss.

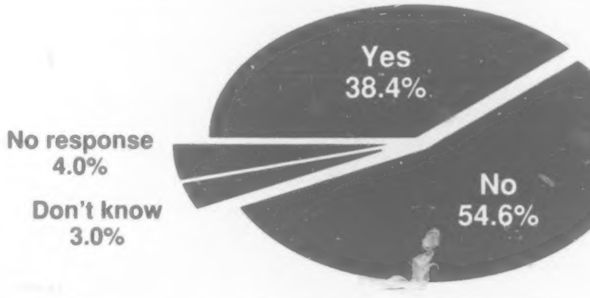
But of more immediate concern are the battle cries emanating from the halls of Congress these past few months. Although many chief financial officers believe that trade sanctions may solve some short-term problems, most indicate that long-term issues of productivity and competitiveness deserve primary attention. However, over 67% of those surveyed expect trade friction between the United States and Japan to increase in the second half of 1987. Also, 62.3% expect the United States to increase tariff barriers on Asian electronics in the next six months. America's newfound protectionist fever has many in the electronics industry worried about the stability of the international marketplace.

The question everyone is asking is: What will happen if Japan retaliates in kind to import restrictions? As Wyss points out, the least harmful response would be if Japan simply mirrors U.S. legislation. That is, if Japan put equal limitations on imports from the United States. But that is the least of America's worries: Japan has more damaging options up its sleeve. It could shut its borders down all together and it could withdraw its financial resources from American markets. Simply put, Japan could wreak havoc on the U.S. economy. ☐

> Over 28% of those surveyed say they expect foreign corporations to increase the rate of acquisition of U.S. firms

INVENTORIES

In the second half of 1987, do you anticipate that your company will build inventory in materials, componentry and/or systems?



Source: ELECTRONIC BUSINESS

With the prices of foreign components increasing, 62.3% of respondents expect tariff barriers on Asian electronics exports to the United States to increase, making them even more expensive and limiting their availability. Similarly, 36.9% expect more U.S. companies to move offshore and 67.6% expect trade friction between the United States and Japan to increase. Also, 28.4% expect the rate of acquisition of U.S. electronics companies by Japanese and European corporations to increase.

OUTLOOK UPDATE

BY BETH KARLIN

Trade issues dominate second-half outlook

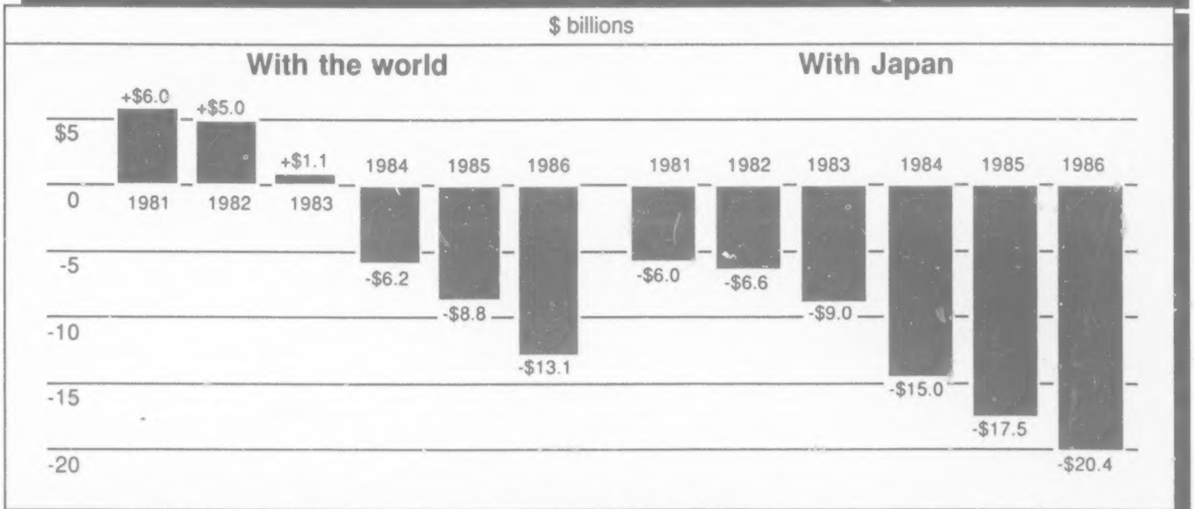
Thanks, in part, to the decline of the dollar, the industry, overall, can look forward to continuing expansion

It was all sunshine and blue skies when President Reagan welcomed Japanese Prime Minister Yasuhiro Nakasone to the White House for trade talks in late April. But the fair weather outside belied the dark clouds inside the Capitol where legislators were debating just how tough to get with Japan in the sweeping trade legislation being considered in Congress. Trade clearly is the key issue in Washington this year. The trade deficit reached a record $170 billion last year and with the buzzwords "economic competitiveness" on everyone's mind these days, Congress is intent on doing all it can to reduce that imbalance.

While Congress haggles over the trade bill, export control legislation and the budget this year, U.S. exports are beginning to pick up on their own — with electronic components and computers leading the way. Indeed, the long-awaited recovery from the electronics industries' deep recession of the past few years appears to be under way.

"Based on first quarter preliminary statistics, we're very pleased," says Mark Rosenker, vice president, Electronic Industries Association. U.S. factory shipments of electronic equipment, components and related products totaled $56.8 billion in the first three months of the year, up about 7% from the first quarter of last year. EIA is projecting that total industry shipments will be between $220 billion and $225 billion this year, up from about $212 billion in 1986.

Thanks largely to the declining value of the dollar on world markets, nonautomotive capital goods exports will rise about 14.5% in constant dollars this year, compared with a 9.5% rise in 1986, according to Data Resources Inc., a unit of McGraw Hill Co. In current dollars, capital goods exports are expected to climb to $88 billion, from $78.2 billion last year, DRI says. "We're definitely seeing im-



U.S. trade balance in electronics

Source: American Electronics Association

Electronic equipment and components

U.S. production ($ billions)

	1986	1987	1988	1989
Communications	$70.2	$72.2	$78.1	$83.7
Computer and office	53.0	55.0	62.1	68.8
Industrial	25.1	25.9	26.7	27.8
Instruments	60.8	63.1	68.2	72.1
Radio and TV	13.2	14.2	15.0	15.9
Total equipment	**$222.2**	**$230.4**	**$250.0**	**$268.4**
Components	44.1	49.3	53.5	57.9
Total	**$266.3**	**$279.7**	**$303.6**	**$326.3**

Numbers may not add up due to rounding

Source Analytics

provements in competitiveness of capital goods exports. And we expect that to continue," says John Jelacic, senior international economist in the Commerce Department's Office of Trade and Investment Analysis.

The U.S. electronics trade deficit with the world market, meanwhile, appears to worsen. While at press time, no one is forecasting the 1987 electronics deficit, it appears unlikely to improve this year. The U.S. electronics deficit with the world market has been getting worse each year since 1983, the last year in which there was a positive trade balance of $1.1 billion, according to the American Electronics Association. In 1986 the deficit climbed to $13.1 billion, from $8.8 billion in 1985. Meanwhile, the U.S. electronics trade deficit with Japan last year climbed to $20.4 billion, from $17.5 in 1985, according to the AEA.

With the fall of the dollar, the cost of some foreign goods are becoming prohibitively expensive here, at the same time U.S. exports are becoming increasingly appealing to foreign buyers. "Those industries, such as computers and equipment, that compete on world markets can take advantage of the decline of the dollar," says Sara Johnson, a DRI senior economist. "Also at an advantage are those segments that have been hurt by import penetration, like semiconductors."

Semiconductor exports, for example, are expected to increase 25% this year, according to the Commerce Department, which projects an 11% rise in total U.S. shipments for the year. In March, meanwhile, the Semiconductor Industry Association, reported that all three key indicators of U.S. semiconductor market business conditions increased, reaching the highest levels experienced by world semiconductor manufacturers since 1984. Average monthly orders for the three months ended in March rose 15.6% to $910.8 million, up from $788.2 in February.

Shipments for March totaled $912.1 million, up 34.6% from February's $677.8 million. And three-month average billings for March totaled $751.3 million, a 6.5% increase from the same figure for February. In March, the book-to-bill ratio for U.S.-, Europe- and Japan-based semiconductor manufacturers doing business in the United States rose to 1.21 (meaning that for every $100 worth of product shipped, manufacturers received $121 in new orders), the sixth consecutive monthly increase.

Buyers, meanwhile, expect to increase their 1987 semiconductor purchases by 13%, according to a Dataquest Inc. survey of ELECTRONIC BUSINESS' top 200 electronics companies (excluding those electronics companies that do not buy components). Last year, a survey of the same group indicated purchases would increase only 7%; which is very nearly what happened in 1986.

Military maneuvers

Industry watchers are also projecting that 1987 will be a year of regeneration for personal computers and related industries. Infocorp, a Cupertino, Calif., market research firm, predicts unit and dollar sales will increase 22% this year worldwide and 25% in the United States.

> EIA is projecting that total industry shipments will be between $220 billion and $225 billion this year, up from about $212 billion in 1986

The jury is still out on military electronics. Growth is expected to slow over the next few years, but then rebound. U.S. production of military electronics will increase only about 4.4% this year and 3.5% in 1988, according to Henderson Ventures, a Los Altos, Calif., market research firm. "Gramm-Rudman legislation and the president's opposition to tax increases leave little room for increased defense spending," says Edward Henderson, president of Henderson Ventures.

In the defense budget, President Reagan is calling for a 2.1% drop in procurement, but a 19.1% increase in research, test, development and evaluation. The RTD&E portion is electronics intensive, and with the administration's emphasis on the Strategic Defense Initiative (SDI), electronics companies should benefit. In general, spending for command, control and intelligence (C^3I) will remain strong, with Henderson forecasting an 8% increase in production for 1987 and a 5.8% increase in 1988. But radar systems are expected to decline 1.2% this year, and then an additional 1.4% the following year, according to Henderson.

Telecommunications, meanwhile, remains soft. "There is some weakness there," says Electronic Industries Association's Rosenker. "Maybe its stiffer competition." After growing 5.8% in 1986 to $70.2 billion, U.S. communication equipment production is expected to grow only about 2.9% this year to $72.2 billion, according to Kent Webb, founder of Analytics, a Palo Alto, Calif., consulting company. Next year, Webb says, production will rise 8.2% to $78.1 billion.

According to Webb, total U.S. production of equipment will rise 3.6% to $230.4 billion, following a fall of 0.4% last year to 222.2%. In 1988, he estimates, production will increase another 8.5% to $250 billion. "Industry is still rebuilding, but by this time next year things should be in relatively good shape."

Despite the falling dollar, many data-processing and communications companies continue to shift production offshore. In the Dataquest procurement survey, about 43.3% of the respondents said they anticipated shifting at least some production offshore. Dataquest estimates that the U.S. semiconductor consumption moving offshore will represent 11.8% of total dollars this year, compared with 9.5% of total dollars last year. While there may be some slowing of movement offshore, says Anthea Stratigos, associate director of Dataquest's Semiconductor Applications Markets service, "overall, we believe that users expect moderate growth in purchases, and that shifts in electronic equipment production offshore may have long-term implications for domestic semiconductor consumption."

Consuming issues

Some believe that the falling dollar overcompensates for what really has been lackluster growth. Worldwide semiconductor consumption measured in U.S. dollars, for example, actually grew 25.6% last year, according to San Jose, California-based Dataquest. Obviously this overstates the real growth in consumption in overseas markets. Japanese semiconductor consumption grew only 1.9% in 1986 measured in yen, according to Dataquest figures. But this translates into a 44.9% growth rate in U.S. dollars. "Although the sharp fall of the U.S. dollar against the yen dramatically overstates the Japanese consumption growth rates, 1986 was a slow year," according to a Dataquest report written by consultants Howard Bogert and Joe Borgia.

Even though much of the growth is due to the weakness of the dollar, industry watchers, nonetheless, see strengthening demand for electronics products this year and next — but at a more moderate rate than the industry had gotten used to earlier this decade. "We expect healthy but moderate growth in world semiconductor consumption in 1987, strengthening into 1988," say Bogert and Borgia. "We seem to miss the fever of the customary upswing, but the reality is a moderate and more stable growth."

Indeed, many analysts echo the optimism of Webb of Analytics. 'This year there will be more demand as well," he says. "There are definite signs that the recession is ending." ☐

BY ANNE KNOWLES

Computers: You can hear the sigh of relief

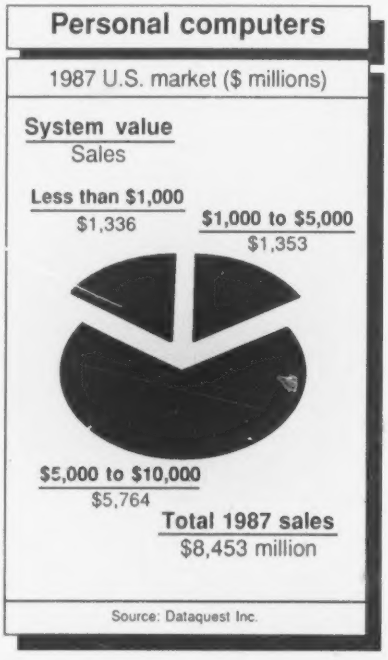
If first-quarter results are any indication, the computer industry is climbing out of the doldrums with a flourish

Throughout the computer industry, you can practically hear the sigh of relief. First quarter results were, with few exceptions, superb. Digital Equipment Corp. posted an 81% gain in profits on a 25% rise in sales. Apple Computer Corp. recorded a 6.6% jump in profits on a surprising 41% increase in revenue. Amdahl Corp., awing everyone including itself, posted 1,050% skyrocket in profits on an amazing 159.5% gain in sales.

Other signs were positive, too. "Some big players are encouraged by order rates," says Richard Mikita, an analyst with International Data Corp. (IDC), a market research firm in Framingham, Mass. "The bookings bode well." New orders for computers and office machinery should increase 11.4% this year, up from a 11.8% drop last year, according to Cahners Economics. Shipments should rise 5.2%, says Cahners Economics, after a 9.6% dip last year.

Personal computers

1987 U.S. market ($ millions)



Source: Dataquest Inc.

IDC anticipated early on that 1987 would be a turnaround year for the computer industry. Mikita expects 7.6% sales growth in the total U.S. computer market, encouraging after a 1.5% spurt in revenue last year. Mikita says users he has recently talked to plan to have "reasonably healthy buying" activity for the remainder of the year.

The fact that the industry is not returning to double-digit growth is not worrisome either, says Mikita. He adds that 7.6% growth is respectable. His forecast, into the beginning of the next decade, calls for growth rates in computer revenue to hover below 10%. The business, says Mikita, has entered into the company of other mature industries.

Others see a trend toward moderation also. "I don't see the same level of capital spending we may have seen two or three years ago," says Charles Fonner, director of systems marketing at Amdahl in Sunnyvale, Calif. "I don't think people are buying excess capacity as they might have before."

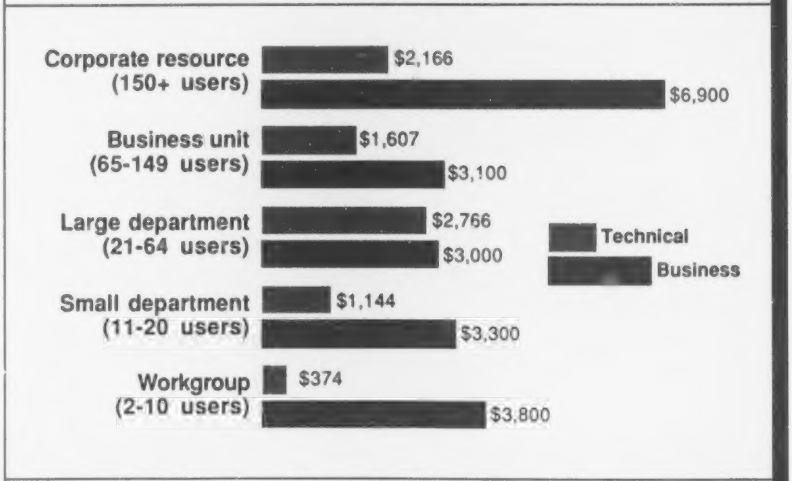
"There are smarter acquisition policies in the user community," concludes Fonner. That bodes well for computer manufacturers, he says, who can now expect a little more predictability in the marketplace. "Users are buying incrementally now," says Fonner. They are buying a little less each time, he says, but they're buying a little more often. The result for manufacturers, concludes Fonner, "will be smooth growth for the next 18 to 24 months."

Spending up

"There is clearly a lot of people buying equipment," agrees Suzanne Peterson, an analyst with First Boston Corp. in New York City. While the indicators are positive for the industry

Computers

1987 U.S market ($ millions)



Source: Dataquest Inc.

as a whole, says Peterson, "it is not going to turn around for every company." Data General Corp., for example, was one of the exceptions during the first quarter party. The Westborough, Mass., mini maker posted its biggest loss ever in its second fiscal quarter, ended March 28. DG reported a $42.6 million loss in net income, including a $9.6 million operating loss. Total revenue for the second fiscal quarter, $315.2 million, dropped 1% from the previous year's quarter results of $318.8 million in revenue.

DG's primary problem, asserts Peterson, is a shift in the industry toward standard operating systems. DEC, DG's principal minicomputer competitor, has not been affected by the trend because its VMS operating system, which runs on the company's VAX computer family, has established itself as a standard. The other ruling operating systems are IBM's MVS mainframe system, AT&T-developed Unix, and MS/DOS, the operating system for IBM PCs and compatibles developed by Microsoft Corp.

That means that other manufacturers running proprietary operating systems, like DG, "must run twice as hard," says Peterson. The remedy for DG, she claims, is to "find some new products wherever there is a demand." Peterson cites any new application that was once accomplished on paper and is now being done by computer as a potential area for any disappointed manufacturer. For example, DG should find something now like computer-aided design/manufacturing (CAD/CAM) was in 1981, says Peterson. "Wang [Laboratories] is trying to do that with image processing," says Peterson. The Lowell, Mass., computer maker reported a 72.4% drop in profits but increased revenue 9% in the quarter ending in March this year.

The Prime of life

Prime Computer Corp. is also showing healthy gains despite the same omnipotent threat of DEC that DG faces. The Natick, Mass., mini manufacturer recorded a 13% rise in revenue and a 28% increase in earnings during the first calendar quarter. Prime, which began targeting CAD/CAM a few years ago, is expected to announce its intentions to zero in on another narrow market soon.

Prime is both an investor in and an original equipment manufacturer (OEM) to Cydrome Inc., a maker of so-called minisupercomputers. Prime should be introducing its minisupercomputer offering, based on Cydrome's 64-bit, emitter-coupled logic (ECL) proprietary processors, sometime this summer. Prime will be the first mini maker to enter the new minisupercomputer market, which to date has been populated by recent start-ups, such as Cydrome. The minisuper market — which is comprised of high-end scientific and engineering applications historically run on supercomputers and superminicomputers — is expected to reach $375 million this year, according to Hambrecht & Quist Inc. in San Francisco.

By all accounts, the minisuper market continues to heat up. So far, DEC is addressing the market through a joint marketing deal with Floating Point Systems Inc., the Beaverton, Ore., maker of attached array processors, to increase compute power on its VAX series for a specific set of problems. In addition, DEC is expected to announce a joint marketing and development deal soon with Cray Research Inc., the supercomputer market leader, according to Jeffry Canin, an analyst with Hambrecht & Quist.

The two start-ups with the highest stake in the minisuper market so far — Alliant Computer Systems Corp. and Convex Computer Corp. — both reported impressive first quarter earnings and revenue. Alliant posted $12 million in revenue, three times that of the same quarter a year ago. The Littleton, Mass., minisuper maker's installed base grew 34%, to 110 systems. Convex reported a 92% rise in revenue, to $14.4 million and shipped 30 systems, bringing its installed base to 127 systems.

The mainframe market appears to be picking up some steam, also. Amdahl's Fonner attributes the company's spectacular first quarter results to both sales of its storage products for mainframes, and system sales of its 5890 series mainframes. "And the indications are that we don't see any slackening in demand," says Fonner. Fonner claims that in addition to new account activity, Amdahl is also seeing robust demand from its installed base. "We are seeing repeat business from existing customers much faster than usual," says Fonner.

IBM attributed its better-than-expected first quarter results from mainframe sales. And other mainframe makers, such as Control Data Corp., NCR Corp. and Unisys Corp., that manufacture computers that are not compatible with IBM's systems, also report business is healthy.

The midrange market may be in for a bit of a shake-up, say analysts. Analysts agree that IBM's 9370 minicomputer, announced last October, will have some impact on the midrange market competition. "IBM is going to make a lot of hay with the 9370," says Van Weathers, a business computer analyst with Dataquest Inc., a market research firm in San Jose, Calif. "It looks like a good machine." Weathers says that in addition to strong sales of its 3090 mainframes, IBM is "stirring up a great deal of business," through 9370 orders. And while Digital hasn't lost any steam, says Weathers, the minicomputer maker may experience a slowdown in taking share away from IBM in the business market.

But that may be the only thing stirring in the market. Most mini and supermini manufacturers have filled out their computer families over the past few years and nary a product announcement is expected for the remainder of 1987. Hal Feeney, a technical computer analyst with Dataquest, expects that DEC, DG and other mini vendors to continue to fine-tune existing products.

IDC's Mikita anticipates "some announcements from smaller companies that will be interesting." In the technical market, says Dataquest's Feeney, Dana Computers Inc. and Stellar Computer Inc. should bring out their high-powered workstation offering by year-end. It will be the first introduction for both start-ups, which are expected to pioneer a new market for desktop computers in the high-end technical market.

Feeney projects that both Apollo Computer Inc. and Sun Microsystems Inc. will be offering increased performance on new systems by year-end as "leapfrogging in the technical workstation area continues." Feeney also believes that systems based on Intel Corp.'s 80386, 32-bit microprocessor, will have some impact on the workstation arena this year.

IBM's 386-based system — while setting tongues wagging in the industry — won't be available until the end of the year. While the low-end models 30 and 50 are available now, the top end Personal System/2, the model 80 based on the 80386, is slated for shipment in the last quarter. And the Microsoft Corp. operating system, OS/2, which has been designed to take full advantage of the 386's power, won't be ready until mid-1988. But the switch to 3.5-inch disks and the new systems' bus structure will be sure to have an immediate impact on the PC market as companies rush to market with add-on products.

But one PC market participant isn't panting. COMPAQ Computer Corp., which announced a 386 machine based on the old IBM standard last year, has made its intentions clear. "Over the past several weeks I've started wondering if IBM didn't introduce the computer industry's version of New Coke when it tried to change the formula for its PCs," said Joseph R. "Rod" Canion, COMPAQ's president and chief executive, at a press conference in New York City in April. "Well, at COMPAQ we're committed to sticking with the 'Classic' formula for success in the computer industry," said Canion. □

BY VALERIE RICE

Semiconductors: Time for cautious optimism

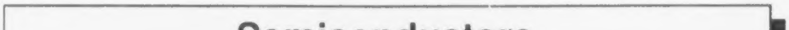
Industry analysts are at odds on the question of how fast the IC market will grow. But grow it will, most predict

The semiconductor industry is back in the black. But a celebration is likely premature, despite evidence that the recent upturn should continue through the rest of the year. The industry, which has taken a beating in the past two years, faces the current revival with caution because, in the words of one senior executive: "It seems like the upturns are shorter than the downturns."

As if afraid to offend the gods, executives whisper cautiously among themselves that things seem to be picking up based on the first half of 1987, and a fearless few dare to say that the industry might get even better in the second half.

Business is indeed better all over, commodity prices are firming and in some cases going up, distributors are seeing more inventory turns, and even the market research firms have raised their forecasts, rather than lowered them.

Dataquest Inc., San Jose, Calif., raised its forecast from the "teens" says senior industry analyst Andrew Prophet, to a 1987 worldwide IC number of 20.5% growth over 1986. Scottsdale, Arizona-based Integrated Circuit Engineering (ICE) raised its forecast as well, predicting 15% worldwide IC growth this year. In-Stat Inc., also in Scottsdale, is well-known for its pessimistic outlook on semiconductor growth (something which has made it relatively accurate in recent years). In-Stat also raised its growth figures to 15%, up from 5.5% originally. In fact, the only industry pundits to downgrade their forecasts were the Semiconductor Industry Association's, they had originally planned on



Sources: Semiconductor Industry Association, Cahners Economics forecast

BY MIKE LEIBOWITZ

Passive components: The recovery is under way

Don't expect a bang-up second half, but there is no question the U.S. component market is strengthening

Manufacturers of passive components and other nonsemiconductor devices are not yet ready to celebrate, but at least they have no reason to be gloomy. Although still on shaky ground, modest growth may finally be returning to the U.S. components industry.

After two lackluster years, order rates for electronic components have gradually increased during the first half of 1987, according to Emmitt Graham, senior vice president at Gnostic Concepts Inc. Graham expects that this increase will continue to accelerate through the second half of 1987 and peak sometime in 1988.

"There's no barnburner out there, by any means, but certainly there is a strengthening recovery," says Graham.

A number of component manufacturers agree that a recovery has arrived. At Sprague Electric Co., Thomas Browne, group vice president for capacitors, reports a positive book-to-bill ratio since the beginning of the year and general optimism. "It looks as if the OEM [original equipment manufacturing] inventories have burned off and we're seeing an upturn in business as a result."

Augat Inc.'s vice president Richard Grubb says that the company has seen some definite improvements in back orders for connectors and sockets. "I really feel that we are back on a track of sustained, solid growth," Grubb says.

Cherry Electrical Products Corp. has seen approximately a 15% rise in sales during the first quarter of 1987 over the first quarter of last year, according to Peter Cherry, president. Cherry is generally optimistic about prospects for this growth to continue. He is concerned, however, that a recovery could be disrupted by continuing trouble in the world economy.

But at Veeco Instruments Inc.'s Lambda Group, Joshua Hauser, executive vice president, says they are still seeing a business climate for power supplies that is "essentially flat." Although he says that Lambda has projected a "modest" growth in bookings in the short term, he is uncertain about the likelihood of continued growth. "Whether this is a sustainable trend or whether it's a little hiccup and we're going to go back into the doldrums is not clear," says Hauser.

> After two lackluster years, the passive component market will continue to accelerate through the second half of 1987 and peak sometime in 1988
>
> Gnostic Concepts Inc.

Lower inventories

Many in the industry agree that a basic factor in allowing a recovery to occur is the whittling down of excess inventory levels that took place during 1986. By the end of 1986, says Gnostic's Graham, excess inventory had virtually been eliminated.

Those that predict continued sales growth for components in the second half of 1987 point to growing production of electronic equipment as the key factor for their optimism. According to Graham, increased demand for computer equipment, in particular, has been a strong motivator in the recovery. He expects this demand to continue its climb into 1988.

For electronic equipment in general, Gnostic Concepts projects that production will grow by over 10% in 1988, up from 7.5% in 1987 and 6% in 1986.

The increase in U.S.-made equipment production is partially fueled by an increase in the value of foreign currencies against the dollar, which makes imported equipment more expensive, and promotes the sales of exports.

U.S. equipment production is also helped by a slowing in the growth in offshore contract assembly, and the relocation of offshore manufacturing back to the United States. Due to increased investment in factory automation in the United States, and more expensive labor costs abroad, "the trade-off between labor costs and capital is no longer a big advantage offshore," says Gnostic's Graham.

Expensive foreign currencies have also helped components manufacturers by making foreign component imports more expensive. At Apple Computer's Fremont, Calif., manufacturing plant, James Bilodeau, materials manager says that Japanese connector manufacturers will not gain

Components

U.S. OEM consumption ($ millions)

	1986	1987	1988
Relays	$682	$697	$724
Switches	562	567	589
Connectors	3,758	3,956	4,267
Capacitors	2,095	2,225	2,302
Resistors	976	1,020	1,048
Printed circuits	4,122	4,361	4,707

Source: Gnostic Concepts Inc.

Components

U.S. OEM consumption ($ millions)

Microwave components

	1986	1987	1988
Active components	$1,729	$1,981	$2,167
Passive components	4,114	4,502	4,832

Active components: amplifiers, oscillators, tubes

Passive components: ferrite units, connectors, switches and switch modules, filters, antennas, limiters, mixers

Source: ElectroniCast Corp.

Displays

	1986	1987	1988
Cathode ray tubes	$1,402	$1,490	$1,606
Other displays	274	310	366

Cathode ray tubes used for all applications: TVs, terminals, instrumentation

Other displays include plasma, electro-luminescent, vacuum fluorescent, liquid crystal, and multisegment light-emmiting diode. Includes electronics if packaged together

Source: Stanford Resources Inc.

	1986	1987	1988
Power supplies	$4,935	$5,345	$5,825

Source: Micro-Tech Consultants

	1986	1987	1988
Transformers	$2,460	$2,700	NA
Inductors	385	425	NA

Transformers do not include power transmission and distribution transformers above 5 kilovolts

Source: Worltech Reports Inc.

Sensors

	1986	1987	1988
Solid state	$1,400	$1,500	$1,650
Electro-mechanical	922	971	984

Source: Market Intelligence Research Co

ground at Apple. "The reason is yen," says Bilodeau. "They've priced themselves out of the market."

The big concern voiced by members of the industry, however, is how the economy will perform over the next six months. A further slowdown in worldwide capital spending during the second half of 1987 could drastically reduce component manufacturers' ability to take advantage of slim inventories and the fallen dollar.

At Hewlett Packard Co., the purchasing department is not planning on a great upswing in business during the next six months. Thomas Cunningham, corporate procurement manager, says that purchases during the second half of 1987 will amount to roughly the same as for the first half of the year, which he says is up a little bit from 1986. The major changes in purchasing activity, says Cunningham, will be from shifts to new technologies, such as surface mount technology.

SMT impact

The move to surface mount technology (SMT) by equipment manufacturers is slow, partly due to the expense of capital equipment and partly due to the lack of a wide range of surface mountable components. Nevertheless, SMT is causing headaches for manufacturers of electronic components. They are required to solve difficult problems in order to address what will undoubtedly be a large future market.

The main technical problem facing components manufacturers is developing products using materials that can withstand the high temperatures of the surface mount process. These temperatures can either cause the component to melt, or cause the circuit board and the component to expand at different rates. In either case, the component fails.

The main marketing problem in attacking the surface mount market — particularly for the connector industry — is the lack of standard surface mount products. Each connector manufacturer is faced with the difficult task of trying to turn their proprietary surface mount product line into an "industry standard."

Despite these problems, components manufacturers realize that the development of surface mount products and other new products is necessary in order to remain on their customer's vendor lists. Equipment manufacturers evaluate their vendors' breadth of product line as one of the criterion used when paring vendor lists and obtaining greater leverage with vendors.

Other criteria important to components customers are price, quality and delivery. In response, components manufacturers are investing in new automated production equipment in order to lower manufacturing costs, improve quality and catch defects before they reach the end of the production line. In line with the move by major customers to requiring just-in-time (JIT) deliveries, many components manufacturers say they will be expanding their JIT capability during the next six months.

The components industry in general has consolidated during the past few years, in order to pool resources and broaden product lines. Additionally, a number of U.S. companies have opened manufacturing plants abroad to follow business overseas.

The main goal for components manufacturers during the past two years has been to put themselves into fighting shape. If the recovery has indeed arrived, their efforts may finally bear fruit. ☐

OUTLOOK UPDATE

BY ALDEN M. HAYASHI

CAE/CAD/CAM: Still waiting for the upturn

While overseas sales are robust, the U.S. market remains sluggish. One reason: U.S. capital spending has been dismal

When CAE/CAD/CAM systems were first marketed more than a decade ago, they quenched a long neglected hunger. Customers were all but starved for CAE/CAD/CAM (computer-aided engineering/design/manufacturing) systems, which help users automate the design, test and manufacture of products as diverse as computer chips, cars and 40-story buildings. "It was a salesman's dream," recalls John J. Clancy, president of the Manufacturing and Engineering Systems Co. of McDonnell Douglas Corp.

Times have changed. Customers today want more than just newfangled products. They want CAE/CAD/CAM systems that fit into their overall corporate plans for automation. "When people are concerned about those sort of things, they tend not to buy . . . . Our sales cycle has definitely stretched out way beyond anything we've seen before," says Clancy.

Not surprisingly, the CAE/CAD/CAM industry has slowed. In the early 1980s, the market was speeding along at an average annual growth rate of 53%, according to Daratech Inc., a market research firm located in Cambridge, Mass. Today, however, Daratech is predicting a mere 14% annual growth rate for the next five years. In particular, Daratech says that the market this year will grow only 11.7%, from revenue of $4.0 billion last year to $4.5 billion. And next year the market will grow 16% to $5.2 billion, according to Daratech.

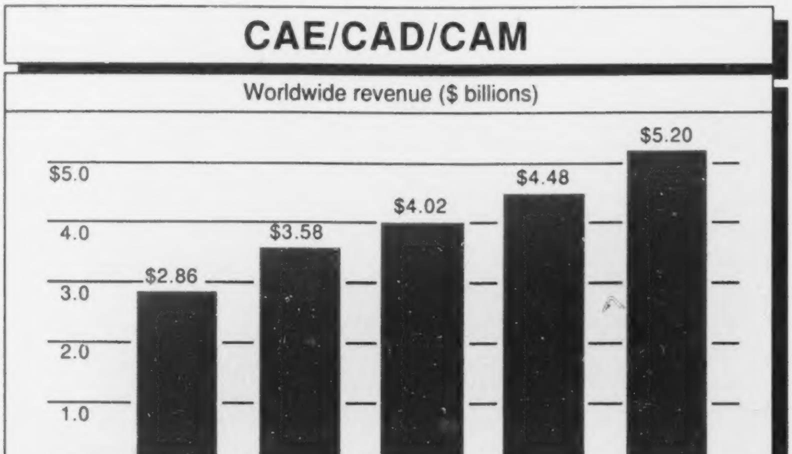
"Before, CAD/CAM was a buzzword and . . . customers would say: 'Oh, CAD/CAM, of course I'll approve the purchase . . .' Now, CAD/CAM has got to fight its way through like any other capital spending purchase," says Patrick Alias, a vice president for sales at Computervision Corp. of Bedford, Mass. CV, like the rest of the CAE/CAD/CAM vendors, reports that sales of its products are now tied to customers' capital expenditure budgets. "We're in the capital spending business," agrees James Meadlock, president of Intergraph Corp., headquartered in Huntsville, Ala.

Dependence on customers' capital expenditure budgets has hurt the CAE/CAD/CAM industry. The predicament of CV customer Varian Associates Inc. of Palo Alto, Calif., is a case in point. When CV introduced new products last year, Varian was impressed. "I liked the new products a lot and I was recommending them to all of our divisions," remembers Don Blackwell, Varian's director of engineering and manufacturing. But Varian did not purchase the products because, explains Blackwell, "we couldn't afford them at the time." Still, Blackwell says that as soon as Varian's capital expenditure budget frees up, he will definitely be buying CV's new products.

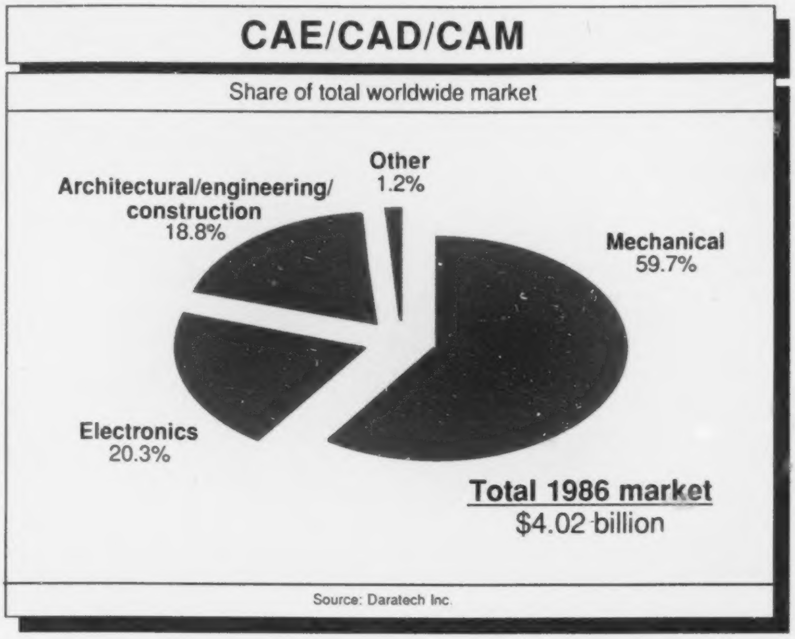
But customers' budgets will not be freeing up any time soon, says Timothy R. McCollum, a vice president of Dean Witter Reynolds Inc. of New York City. According to him, overall U.S. capital expenditures will increase by only 1.7% this year, down from 4.0% last year, 10% the year before and 20% in 1984. And for next year, McCollum is predicting a meager 2% to 3% growth. McCollum lists some of the reasons for his pessimistic outlook: low inflation, low factory capacity utilization and the recent tax-law changes. All of these factors, he says, lowers the incentive for customers to purchase equipment.

Because of the pessimistic capital expenditure outlook, Daratech president Charles M. Foundyller says that the competition in the CAE/CAD/CAM industry will intensify. "There's going to be blood on the floor," he predicts. Adds Robert L. Gable, CV president: "The U.S. economy is weak right now in the capital spending area. People are struggling for a declining part of business in the United States." According to Daratech, only three of the top 10 companies were profitable last year: IBM, Intergraph and Mentor Graphics Corp. of Beaverton, Ore. Staying profitable, says Intergraph president Meadlock, is the fundamental problem that faces all CAE/CAD/CAM companies today.

The heated competitive environment will cause bankruptcies, mergers and acquisitions among the myriad of CAE/CAD/CAM companies, contend industry executives. Many feel that the industry is already overcrowded. Indeed, a CAE/CAD/CAM directory published by Dataquest Inc., a market



Source: Daratech Inc.


CAE/CAD/CAM

Share of total worldwide market

Source: Daratech Inc.

research firm located in San Jose, Calif., lists more than 600 companies in the industry. Consequently, Dean Witter's McCollum has some advice for prospective CAE/CAD/CAM customers: "I'd be very cautious about buying from the small companies."

Earlier this year, Valid Logic Systems Inc. of San Jose acquired Telesis Inc. of Chelmsford, Mass. Says Gerard H. Langeler, Mentor executive vice president: "There'll be more consolidations. There has to be. Too many people are struggling for survival."

In addition, strategic alliances will take place also because CAE/CAD/CAM companies have found that they cannot by themselves supply the complete solution to customers, contends Jerry J. Robertson, vice president for marketing and sales at Applicon Inc., a Schlumberger Ltd. division located in Ann Arbor, Mich. Even mighty IBM, the No. 1 vendor in the industry, admits as much. "No one vendor can really do it all," concedes Robert P. Tiel, head of Big Blue's electronics and architectural/engineering/construction CAE/CAD/CAM efforts.

Strategic alliances and mergers among vendors will also occur because of end users' demands. "Customers want to deal with a smaller number of vendors in a more intensive way," says Philip L. Read, CV senior vice president. Intergraph's Meadlock explains that most customers, even large corporations, are not capable of integrating products from the different CAE/CAD/CAM vendors by themselves.

A price erosion

Although the CAE/CAD/CAM market has been sluggish in dollar volume, unit volumes have soared, claims Daratech's Foundyller. According to him, while the market will grow only 11.7% in dollar terms this year, it will increase by 60% in unit volume. That's terrific, says CV's Alias, except the vendors get paid in dollars, not units. Adds Foundyller: "We're having a great time at the party but the ship has sprung a leak."

The discrepancy between dollar and unit sales is being caused by a huge price erosion in the marketplace. The 1979 average seat price of $180,000 plunged over the next seven years to arrive at $26,000 last year, according to Daratech's figures. Contributing to the decline was the advent of the personal computer which replaced pricier 32-bit supermicrocomputers as the engineering workstation of choice at the low end of the market. CV's Alias says that since 1985, "we came down from $100,000 to $50,000 per seat in about two years."

Alias says that the price erosion has recently slowed and he predicts, "I think it will stop but I don't know when. The rock-bottom price will be at the PC level." Adds McDonnell Douglas's Clancy: "Pricing is the stickiest issue for us."

Look for more strategic alliances and mergers as the CAE/CAD/CAM industry starts to mature, industry executives say

International remains strong

International markets have continued to be the one source of cheer in the CAE/CAD/CAM industry. Sales in foreign countries have remained robust, in part due to the weak dollar which makes U.S. goods cheaper when sold abroad. "The weak dollar has been a Godsend for this industry . . ." says Intergraph's Meadlock.

"The implementation of CAD/CAM now is more rapid overseas," claims McDonnell Douglas's Clancy. Although McDonnell Douglas's overall CAE/CAD/CAM business stumbled last year, the company's overseas sales grew by more than 30%, according to Clancy. He adds that about a quarter of his company's CAE/CAD/CAM business is now overseas.

At other companies, international sales account for an even higher percentage of total revenue. More than half of Calma's electronics CAE/CAD/CAM sales last year came from outside of the United States, according to Bruce Gregory, a senior vice president of this General Electric Co. subsidiary based in Milpitas, Calif. Daisy Systems Corp. of Mountain View, Calif., reports that sales in international markets now account for 50% of the company's total revenue, up from 30% just a couple of years ago, according to Robert Moore, director of marketing. And at CV, the figure is 60%.

But vendors have by no means given up on the U.S. market. "I think '88 could be pretty good. If, in fact, the electronics slowdown really continues through '87, that would have been the third year. That's a long time for it to be down. And at some point, the natural course of economic events is likely to pick it up," says Mentor's Langeler.

Adds CV's Alias: "Customers are *delaying* investments; they are not stopping investments. And they cannot delay orders forever. You can only tighten expenses up to a point. If you want to live, you have to eat." ☐

OUTLOOK UPDATE

BY DAVID CARD

Test and measurement: A return to sales growth

Dragged down by ATE, the market was flat last year. So far, 1987 looks better, and sales will go over $7 billion

It is nothing to write home about, but growth is growth. After an essentially flat year in 1986, the world market for test and measurement instruments should grow more than 7% by the end of 1987. San Jose market research firm Prime Data Inc. estimates 1987 will finish with over $7 billion in sales.

"We'll see some strengthening throughout the year, but not a whole lot," says Prime Data president Galen Wampler. "It won't be a bad year or a great year," he adds. "We scaled back a little because things haven't taken off really fast in the U.S., to say the least."

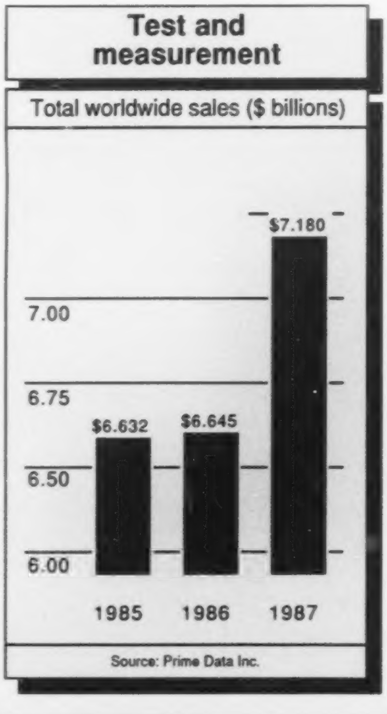
The twin towers of instruments — Hewlett-Packard Co. and Tektronix Inc. — are tracking the industry, while smaller companies are more chipper. For instance, Northwest Instrument Systems Inc. already had a good year in 1986, growing 70% to over $10 million in sales — mostly from its performance analyzers that plug into IBM personal computers. President Lawrence Sutter sees more of the same for the rest of '87. He expects his Beaverton, Ore., company to go well over $15 million by selling to computer and telecommunication companies. To the conventional wisdom that the computer slump has held back participants' equipment spending, Sutter answers: "Well, they're buying our stuff."

At a recent trade show "things were upbeat, compared to the last couple of years," says Dean Dawson, sales manager for Kikusui International Corp. in Gardena, Calif. He claims Kikusui got twice as many sales leads as last year, even though show attendance was slightly down. "Last year, customers weren't very much alive. They were just going through the motions, kicking tires," he says. Kikusui just had its best month in its eight-year history, Dawson says. Sales are 12% higher than last year's roughly $10 million. "That's not the 25% to 26% growth you like to see, but it's all right," he says.

One of Kikusui's strengths, Dawson claims, has been a low-cost digital oscilloscope that has "taken off like gangbusters." As for which end markets are hot and which are not: "Aerospace has never slowed down," Dawson says, "but the rental equipment market is totally dead." He maintains that the rental business has a direct correlation to interest rates — with money cheap to borrow, no one needs to rent.

ATE upturn

Prime Data's Kenneth Neff forecasts a 6% growth in world sales of automatic test equipment (ATE). He cautions that that is "predicated upon continued growth in semiconductor devices." It looks good so far, Neff says, and if things keep up, all that excess capacity the chip makers took on during the 1984 equipment gorging will be used up.


Test and measurement

Total worldwide sales ($ billions)

Source: Prime Data Inc.

"The semiconductor test side is doing better. They're talking with a lilt in their voices," says Joseph Lassiter, Boston-based Teradyne Inc. board test vice president, concerning his chip test cohorts. Although the board test business was slower to slump and now slower to come back, Lassiter sees good potential sales to makers of add-in boards for IBM's PC AT and an ever-sturdy military market. Military contractors, he says, like to deal on 12-year strategies, and so keep up their equipment budgets.

"The military business is a constant," agrees Brent Bilger, military product manager for component tester LTX Corp. of Westwood, Mass. "That's one of the reasons we're getting in. Maybe if we had a bigger percentage of military business, the downturn wouldn't have been so bad." Bilger adds that military test labs have recently started to buy equipment.

Another constant in ATE is Europe. "Our European business has been carrying us for awhile now," J. Robert Held, vice president of Concord, Massachusetts-based GenRad Inc. says of his board test business. Things hit bottom last year, Held says, but the worst is over.

A yen for stable currency

One of the faster-growing segments, according to Prime Data, is logic analyzers. "The logic analyzer is becoming the general-purpose tool in the lab for digital work, just like the oscilloscope is for analog," Wampler says.

However, a potential end market for logic analyzers that has failed to materialize is in field service. "The philosophy for a long time was to get the technician in the field to do repair," says John Adam, vice president for marketing of Gould Inc.'s Design and Test Systems Division in Cupertino, Calif. "The problem was inventory float, and Federal Express solved the problem." Instead of using logic analyzers to track down and repair malfunctions in computer boards, for instance, technicians merely "Fed Ex" the faulty board back to the factory.

Logic analyzer makers, at least, are not facing one traditional instruments bogeyman — Japanese competition. The Japanese have little presence in

Test and measurement

Worldwide sales by segment ($ millions)

	1985	1986	1987
ATE	$1,722	$1,565	$1,660
Oscilloscopes	912	948	1,040
Microprocessor development systems	521	470	500
Logic analyzers	241	267	300
Other instruments*	3,236	3,395	3,680

*Includes digital multimeters, voltometers and signal generators

Source: Prime Data Inc.

the logic analyzer market as yet, Adam contends. "If they were coming in, I would have expected to see them in two years ago," he says. "And now they would be facing the currency problems. The yen is yet an additional barrier."

Is the strong yen a real issue? "Yeah, it's a problem," admits Frank Orrow, manager of the Instrumentation Department of Panasonic's Memory Systems Division in Secaucus, N.J. Panasonic is a subsidiary of Matsushita Electric Industrial Co.

In Japan, Matsushita is fighting currency inflation across instrument segments with economies of scale. Orrow says the company is forcing oscilloscope prices down by tripling production and thus buying components at volume discounts. Redesigning some models to cut down the amount of circuitry is another tactic.

Likewise, Kikusui's Dawson says that they are "squeezing out everything they can" in Japan. Kikusui buys subassemblies, and is pressuring its subcontractors in order to keep from raising prices. Iwatsu Instruments Inc. is also biting the bullet over the yen. "At this point, there has been no user price changes" in Iwatsu's digital storage oscilloscope, says North American sales manager Alexander Orloff, out of Carlstadt, N.J. "But it's definitely affecting and squeezing margins for everybody."

To host or not to host

Sales of microprocessor development systems (MDS) will not reach their 1985 peak, Wampler says. But that is because suppliers are taking the computers out of them, bringing the dollar numbers, if not the units, down.

Hewlett-Packard is in the process of weaning its customers from a standalone system to one that plugs into its workstation. HP has sold over 500 of its hosted boxes since last summer's introduction, but this compares with an installed base of around 18,000 of the older models. It is all a matter of convincing engineers that an MDS is a system, rather than an instrument, says Fort Collins Engineering Operation marketing manager Brad Miller, in Fort Collins, Colo. "We'll see how that goes," Miller says.

HP's slow shift in MDSs reflects the industry's continuing slow movement in plug-in instruments. A few years ago, PC instruments were predicted to be the next thing, but the market has been sluggish at best. Miller says HP's line of PC instruments "is not our hottest selling by any means," although he concedes that "is where the action is" in MDSs. HP does not yet offer a PC-based MDS.

National Instruments of Austin, Texas, would like to carry the PC instrument to its logical conclusion. National touts what it calls "virtual instruments," created in software. Marketing manager Billy Harris also sells instrument controllers and plug-in instrument boards. He expects that in the long run, digitizer sales will go up, but spectrum analyzer and network analyzer sales will shrink as these instruments are absorbed in software. National Instruments is one of the first engineering-oriented company to jump on the new Macintosh II from Apple Computer Inc.

> The world market for test and measurement instruments should grow more than 7% by the end of 1987
>
> Prime Data Inc.

"I don't deeply believe in hosted systems," confesses Ken Pine, sales and marketing vice president for MDS maker Sophia Computer Systems Inc. in Santa Clara, Calif. Still, Sophia is keeping its options open, particularly through a joint effort with Dolch Logic Instruments GmbH.

Wheeling and dealing

The Dolch deal is less indicative of computer-hosted instruments, than of a general trend toward team-ups. Pine says Sophia was "wholly unsuccessful in Europe" using sales representatives. Dolch gives a ready-made entry to that market, and adds logic analyzers to Sophia's product line. This spring, Gould made a joint-marketing arrangement with Siemens AG. N.V. Philips went one better — it recently announced its intention to buy a piece of John Fluke Manufacturing Co. Inc. to gain smoother U.S. distribution.

Meanwhile, an arrangement with Case Technologies Inc. gives Sophia access to computer-aided engineering (CAE) tools, a double-edged trend of dealing and CAE-connecting. Northwest Instruments cut a deal with Taiwanese emulator supplier Microtek International to expand its offerings in another acronymic market — CASE, for computer-aided software engineering. Both instrument giants — Hewlett-Packard and Tektronix — have internal CAE and CASE efforts that dwarf those of the smaller instrument companies.

Northwest Instruments' president Sutter likes Microtek's speed to market with an emulator for Intel Corp.'s 80386 microprocessor — he claims it beat Intel. Also, Sutter says that Taiwan manufacturing will keep hardware prices competitive and that Microtek has sales clout in Europe.

Finally, start-ups are always good for a little cheery news. Three-year-old Hypres Inc. of Elmsford, N.Y., this year introduced what it claims to be the first commercial product based on Josephson junction technology. These superconductive circuits populate an ultra high end oscilloscope. Late last year, Campbell, California-based Outlook Technology Inc. brought out what amounts to an ultra high end logic analyzer. "This is not the computer industry; you don't create giants overnight," says Outlook president B.J. Moore of his chances for big sales now. At least he has guaranteed shelf space — a handful of reps have invested in Outlook. ☐

BY JOHN KERR

Computer peripherals: Look for a stronger second half

It's not quite time to break out the bubbly, but printer makers and storage vendors have less reason to complain

They are not exactly breaking out the champagne yet. But halfway through 1987, computer-peripherals makers are cracking a smile or two as some recovery in demand yields a healthier year all around.

It wouldn't be hard to be more upbeat: compared with 1985's ravages and 1986's lull, 1987 is positively popping. But the definition of growth has changed: vendors no longer expect the parabolic sales curves of the early '80s; instead, they are pleased with 15% annual pickup.

Stellar sales of desktop business computers and personal computer-based engineering workstations are spurring much of the peripherals progress. Increasing PC power is itself a catalyst: 32-bit microprocessors like Intel Corp.'s new 80386, now shipping in volume, enable more terminals to be hung on a PC, for instance.

During the first quarter of 1987, nothing caused more ulcers for peripherals executives than the nerve-jangling anticipation of the second-generation PCs from IBM. But the April debut of the Personal System/2 series brought more opportunity than obstacles.

Big Blue's entry

First, the new Big Blue PCs fail to shoot down clone makers, whose demand for everything from enhancement boards to tape drives will continue as a result. Second: open architecture and limited memory on some of the PS/2s underwrite a future for board makers. One company, Orchid Technology Inc. of Fremont, Calif., has already unveiled a memory board which it claims makes it the first independent company to develop add-ons for the Personal System/2s. And more products are appearing daily.

Third: the new PCs come with 3.5-inch floppy disk drives, a definite endorsement for 3.5-inch drives in general. And fourth: the launch of the computers themselves eclipsed the parallel appearance of IBM's first optical-storage product, the heavenly sign long sought by makers of optical drives and media.

The new Macintosh PCs from Apple Computer Inc. are creating a stir of their own; their open architecture is the jackpot that enhancement-board makers like AST Research Inc. of Irvine, Calif., bet on two years ago when they set up divisions to cater to anticipated after-market demand.

Big Macs and Big Blues aside, peripherals vendors are catching wavelets from storms in global-finance fields. Inflation of the yen is hurting Japanese suppliers: "It means a lot to our margins both here and in Japan," says Dennis Flanagan, senior vice president for sales and marketing at printer firm Okidata, a group of Hackensack, New Jersey-based OKI America Inc. OKI has increased its prices 7% as a result.

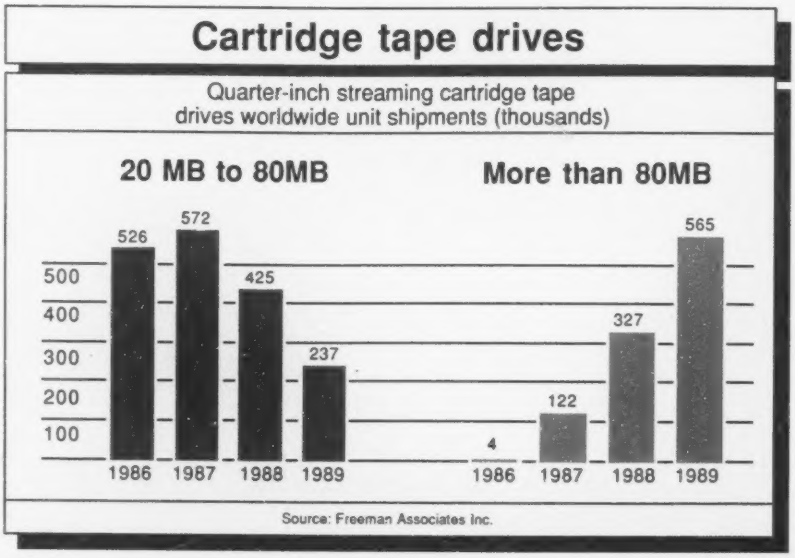
Another printer vendor, JDL Inc. of Westlake Village, Calif., has staved off the worst of the damage by taking a conservative financial stance early on. It pegged its operations to a 150 yen-per-dollar exchange rate some months ago, but will wince to see it drop below that. Meanwhile, the exchange rate bias in their favor appears to be doing little for U.S. manufacturers.

In general, 1987 is giving disk-drive makers reason to look less beaten. While the business remains competitive to the penny, several players are beginning to show their old stuff again. Chatsworth, Calif., hard-drive performer Micropolis Corp. recently posted a 66% gain in first-quarter earnings on 22% higher sales. Quantum Corp. of Milpitas, Calif., through its Plus Development Corp. subsidiary, is pushing sales toward new highs.

A new spoor is exciting a handful of disk drive hounds: soaring demand for 3.5-inch Winchester drives. "Up, up, up!" is how a jubilant William Schroeder describes his company's prospects. As president of San Jose, California-based Conner Peripherals, a start-up founded last year by disk drive doyen Finis Conner, Schroeder expects to double today's daily production of 1,000 40-MB 3.5-inch drives by this fall.

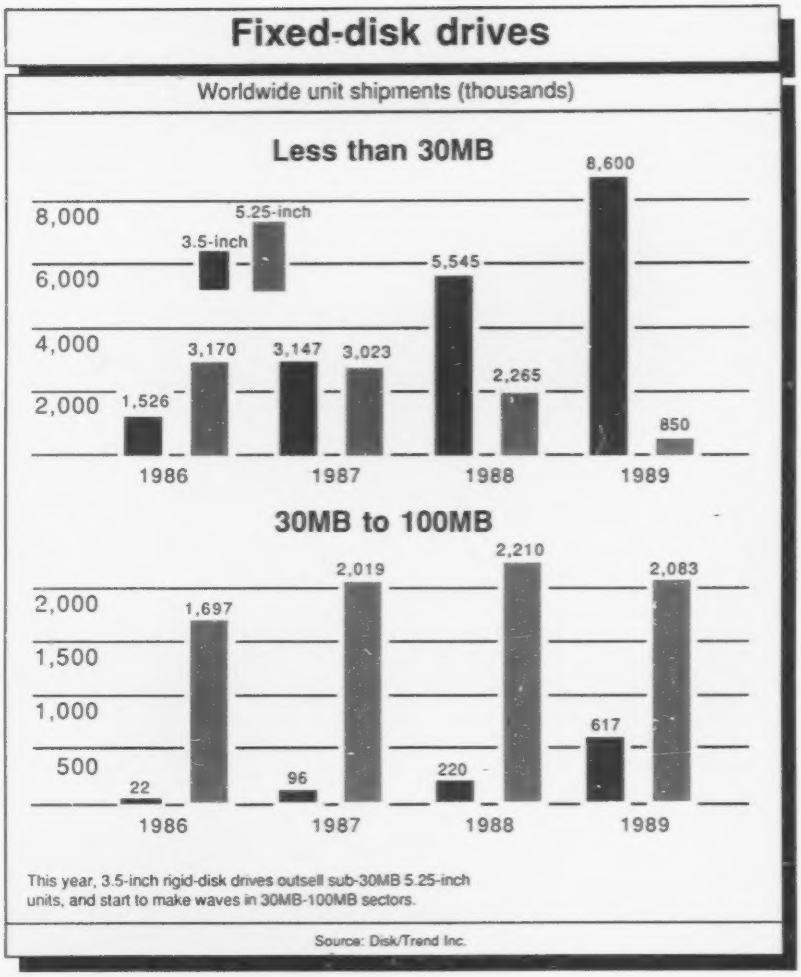
Schroeder delights in IBM's inclusion of 3.5-inch drives in its new PCs, even though they are floppies. "That's extremely bullish for us," he says. But not directly: the drives are apparently being built by IBM in Japan.

That ought to worry Seagate Technology of Scotts Valley, Calif., 27% of


Cartridge tape drives

Quarter-inch streaming cartridge tape drives worldwide unit shipments (thousands)

Source: Freeman Associates Inc.



This year, 3.5-inch rigid-disk drives outsell sub-30MB 5.25-inch units, and start to make waves in 30MB-100MB sectors.

Source: Disk/Trend Inc.

whose sales — chiefly 5.25-inch units — have been going to IBM. Although Seagate launched its own 3.5-inch drive this spring, the unit is only being sampled by original equipment manufacturers (OEMs). Seagate feigns nonchalance: "I don't think that demand will shift [from 5.25-inch to 3.5-inch] overnight," says marketing director Carter O'Brien.

Purchasers of the larger drives confirm this. At military computer maker Rolm Mil-Spec Computers in San Jose, peripherals product manager Thomas Russell reports stronger demand for ruggedized 5.25-inch drives as 8-inch units decline.

The trend toward higher disk-memory storage in PCs is lighting up backup tape drives that last year saw disappointing order levels. Says Raymond Freeman Jr., president of market research firm Freeman Associates Inc. in Santa Barbara, Calif.: "As disk capacity goes up, awareness of the need for backup is recognized."

Following industry consensus on standards and endorsement of quarter-inch formats and technical standards by IBM, quarter-inch cartridge tape drives are on the up, according to Freeman: the 80 MB-plus sector is the one to watch, with 1987 shipments of 44,000, up from 4,000 last year. Minicartridge drives, using quarter-inch tape to store up to 40 MB, are also coming into their own in 3.5-inch form factors.

That is music to the ears of tape-drive makers, like Cipher Data Products Inc., and cartridge makers, like Data Electronics Inc., both of San Diego. R. Gordon Root, vice president of strategic planning and marketing at DEI, claims his shipments have doubled to a million units this year.

Cipher Data, which earlier seemed to have stalled in quarter-inch drives, nevertheless showed a 10% to 12% gain in overall sales last year. Its earnings are creeping back up: third-quarter profits, ended March 31, topped $1.3 million versus $954,000 in the second quarter. Cipher has high hopes for the half-inch streaming tape drive — a joint development with IBM — which it will belatedly unwrap this fall. However, the half-inch tape market has yet to make much noise.

Controller boards and chip sets for disk and tape drives are also experiencing a strong tug from customers. According to Vipul Mehta, vice president of market research firm Peripheral Concepts Inc. of Garden Grove, Calif., U.S. controllers manufactured this year will be worth $827 million, topping $1 billion by 1988.

The optical option

One group of peripherals makers is pinning great hopes on 1987. Manufacturers of much trumpeted write-once optical-memory drives expect their big break this year. "Now that IBM has said that optical is real, everybody's jumping in," says Robert Akers, marketing vice president at Colorado Springs vendor Information Storage Inc. (ISI). Edward Rothchild, chairman of market analysts Rothchild Consultants of San Francisco, has tripled his estimates of write-once drive shipments to 75,000 for 1987.

Buoyed by a development contract for ruggedized 300 MB optical drives from Honeywell Inc., ISI expects to double sales this year to almost $10 million. At the optical-drive division of Laser Magnetic Storage International, also in Colorado, a spokesman points to increasing order sizes, a sign of the industry's coming of age. "Interest in optical is now turning into orders," he says.

In terminals, San Jose-based Wyse Technology continues to prove that demand is dynamic — as long as you give the customer value for money, such as smart terminals, enhanced keyboards or white phosphor screens. Wyse's fiscal 1987 ended March 31 with sales of $250 million, up from $166 million the year earlier. "I think we can do that again. Business is good," says president Phillip White.

The modem arena remains rough-and-tumble, particularly for those trying to do business in 1,200 baud and under product. "It's going to be another tough year, frankly," says Maurice Bailey, sales vice president at Racal Vadic of Milpitas, Calif.

Bailey and others see more thrills

up the baud scale. Prices of 2,400-baud modems are stabilizing as dollar sales reach 25% annual growth rates. Rockwell International Corp.'s Semiconductor Products Division in Newport Beach, Calif., reports a similar upturn for its chip-based 2,400-baud modem "engines." And early demand for Racal's new 9,600-baud units — which use Rockwell modem modules — has helped prop fiscal 1987 sales 10% higher.

Keyboards look better after the battering that sector took in 1985. Digitran, the small Pasadena, Calif., division of Xcel Corp. that concentrates mostly on custom keyboards, reports a 1987 sales jump of over 10%. Key Tronic Corp. expects a 25% increase in unit-shipment growth for fiscal 1988, ending next June 30.

Pricing pressures

Pricing pressure continues, though — at roughly 9% annually, according to Key Tronic's sales and marketing vice president Randy Pierson. That in part accounts for Key Tronic's flat 1987 in both sales and net income, as does persistently unexciting action from mainframe and minicomputer customers that still constitute the bulk of the Spokane, Wash., keyboard maker's revenue.

Output devices remain a mixed story. At the low end, it's no picnic. "In the low end, nine-pin dot-matrix printers are having a rough time," admits Okidata marketing chief Flanagan. Laser printers, averaging 50% annual growth, promise escape to the land of higher profits. Okidata is late to that market: only 5% of sales are sourced from the zippy laser units. But, by this time next year, predicts Flanagan, they could provide 20% of his company's revenue.

PC workstations are fueling fires at Lockheed Corp. subsidiary CalComp, a prominent maker of plotters in Anaheim, Calif. Lawrence Sanders, marketing vice president, cites a 30% step in shipments of CalComp's 1040 plotters to 12,000 units yearly.

At the high end — large electrostatic plotters used by the design shops of aerospace giants — demand has been in the tank because of the capital cost of the equipment, according to CalComp's Sanders. In May, CalComp used new manufacturing efficiencies to cut prices on its big color electrostatics from $100,000 to around $60,000. "We expect to reset the market. In essence we're selling color at monochrome prices," says Sanders.

BY MARK MEHLER

Semiconductor production equipment: No consensus

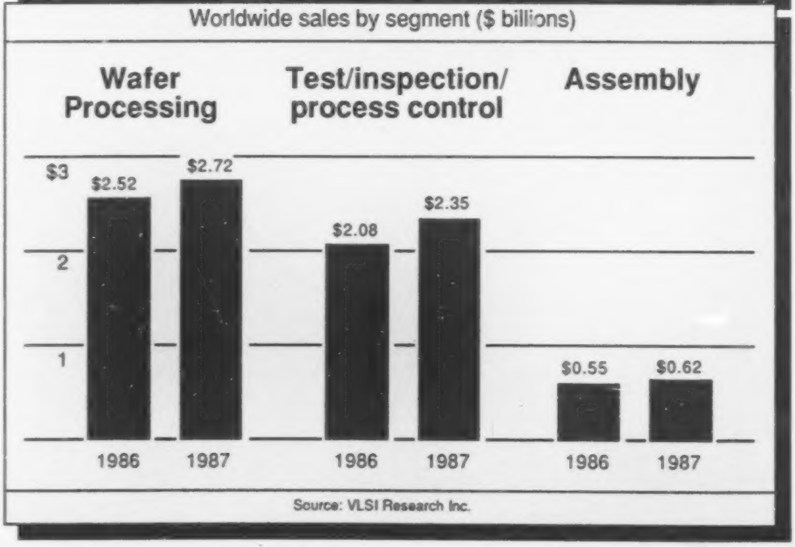
Some analysts are forecasting a sharp rebound in the second half. But other observers are less sanguine

Semiconductor equipment suppliers are ready to close the book on the longest and deepest recession in their history. However, there is a catch. A growing number of observers are questioning the equipment industry's long-term future.

This outlook is reflected in the projections of VLSI Research Inc., a San Jose, Calif., market research firm which sees sales of integrated circuit equipment rising steeply in the third and fourth quarters of 1987. VLSI's G. Daniel Hutcheson says that this year's market for wafer fabrication, test and assembly equipment will reach $5.69 billion, a 10.5% increase over last year's $5.15 billion. Second-half 1987 revenue will hit $3.42 billion, compared with $2.41 billion in last year's six-month period, and $2.27 billion in the first half of this year. Hutcheson adds that equipment book-to-bill ratios will likewise soar in the next six months, reaching 1.9:1 in the third quarter, compared with 0.77:1 in the same period of the previous year.

"The personal computer market is already impacting sales of semiconductor equipment," argues Hutcheson. "Intel's microprocessor business, for one, is being driven by the new IBM PCs and the AT. Telecom markets are also strong. This year is looking better." Sidney Hoffman of Josephthal & Company Inc. in Boston says that pent-up demand in the personal computer market could create an overnight explosion on the semiconductor side.

However, observers are nowhere near as sanguine about 1988 or 1989. VLSI Research has just scaled back its 1988 forecast to $5.74 billion, virtually level with 1987. VLSI believes that the semiconductor equipment segment, which is currently "out of sync" with the rest of the U.S. economy, will catch up to a major economic down-


IC production equipment

Worldwide sales by segment ($ billions)

Source: VLSI Research Inc.

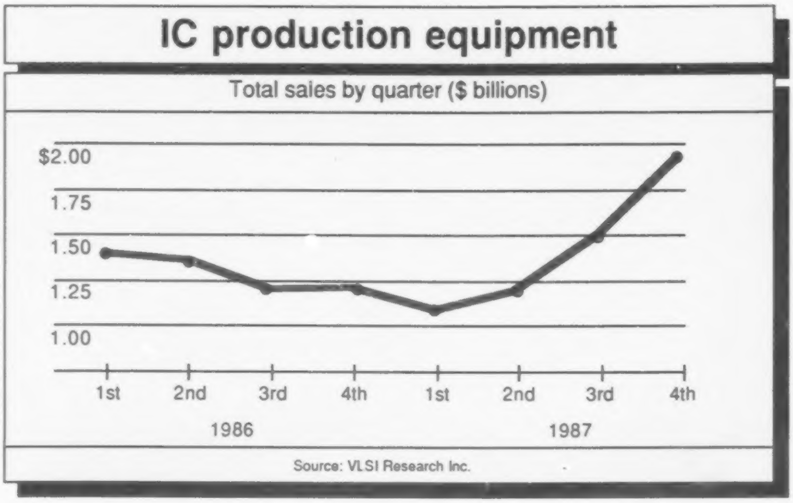
turn late next year. Hutcheson sees book-to-bill ratios dipping as low as 0.47:1 in 1988's third quarter.

Stephen Balog, an analyst at Prudential-Bache Securities Inc., deflated the psyches of some equipment makers at a recent Semiconductor Equipment & Materials Institute (SEMI) luncheon in New York City, by pointing to "serious long-term troubles" for the industry. Balog cited several negative trends, including a slowing of semiconductor device growth from a range of 18% to 19% a few years ago to one of 13% to 14%, due largely to declining growth in the data-processing segment, which consumes nearly one-third of all ICs. Moreover, the analyst noted device makers are being forced by Wall Street to slow capital spending to improve their return on assets. Future growth of the equipment business, Balog suggests, will be equal to, or even lower than, growth in semiconductors, a radical and troubling historical shift.

More bad news

More bad news from Balog: A continued shakeout, fewer start-ups as venture capitalists and corporate investors pull away and, perhaps most critical, an abandonment of the dynamic random-access memory (DRAM) market by U.S. companies, which eliminates a major reason for buying new leading-edge capital equipment. Application specific ICs (ASICs), to which many former DRAM players are moving, do not require the same sophisticated process equipment as 1Mb and 4Mb memory devices, says Balog. Thus, users will have more incentive to optimize existing equipment rather than buy new gear, he concludes.

At the same time as equipment makers face these pressures and many lose control of their balance sheets ("There are quite a few financial basket cases in the equipment industry," says Prudential-Bache's Balog), their customers are weighing in with tougher demands. Richard Aldrich, Intel Corp.'s capital acquisition manager, expects his equipment suppliers to be able "to turn on a dime" when Intel is ready to ramp up. "We're at a crucial point right now," says Aldrich, noting rising IC book-to-bill ratios. "Our suppliers have to have faster response time. No more traditional approach, which was: Give me a forecast and we'll stretch leadtimes as we add capacity. It's a different world. Equipment makers have to work more closely with their own suppliers."


IC production equipment

Total sales by quarter ($ billions)

Source: VLSI Research Inc.

Such comments suggest to some analysts that equipment makers will face the same pressures over the next six months that they faced in the frenzy and subsequent collapse of 1984-1985. "There is a possibility that in 1988 you'll see bookings fall apart and backlogs disintegrate, just as they did the last time," cautions Hutcheson, who had advised clients to be cautious back in mid-1984 and is doing the same in mid-1987.

Equipment makers themselves are witnessing stirrings of a second-half revival, but they recall a similar scenario in early 1986, when an expected turnaround turned to dust. "The feeling around the equipment industry seems to be pretty unanimous that we're experiencing an uptick in bookings," says James Greed, director of technology for General Signal Corp.'s Semiconductor Equipment Group, a broad-line supplier. "However, how long the upswing will last and how we should react are big questions." Greed prefers to view gains in equipment utilization as a long-term plus for the industry. "We have to work with our customers to help them cash in on the gains we've made over the past 18 months," he says. "Over the short term, you might sell fewer pieces of equipment, but the industry is going to be much healthier in the end. We're not about to put ourselves out of business."

> Equipment makers themselves are witnessing stirrings of a second-half revival, but they recall a similar scenario in early 1986

As in the past two years, equipment firms offering process technology breakthroughs or yield-enhancement products, rather than simply offering new capacity, are faring best. "If it weren't for our new systems, we would be in trouble," says James Bagley, senior vice president of Applied Materials Inc. — which has introduced new-generation ion implanters, epitaxial reactors and chemical vapor deposition systems during the past 18 months. About 60% of Applied's fiscal 1986 revenue of $149 million was derived from new-generation products, says Bagley, compared with 7% of sales the previous year. "In this environment," he says, "new is what sells."

Still, there is the danger of moving too soon, a product marketing problem that has plagued the IC equipment industry for years. "An example is the deep UV excimer laser steppers coming to market," says Philip Papoojian, vice president for sales and marketing at 2-year-old start-up Voyager Technologies Inc. "At this point there isn't even a deep UV resist available." Papoojian says that Voyager is navigating through the rough waters by offering concrete scientific and economic justification for its product — an automated system to control static in a clean room. "We're selling the idea of getting better usage of the installed base. That's the only way we're going to grow the business in these times." ☐

OUTLOOK UPDATE

BY BRUCE C.P. RAYNER

Distribution: A glimmer of hope in a rising market

While the uptick appears substantive, the mood of distributors remains cautious in the second half

As a rule, distributors are an optimistic bunch. But while a handful of outspoken optimists are heralding the recovery, many remain skeptical. Still, there is no denying that business is strengthening. The question is whether that growth can be sustained.

The main reason for the hesitation is that a similar uptick happened in the first half of last year. Business was improving, sales increased and inventory was rebuilt. By third quarter, though, it was evident that the supposed 1986 recovery had undergone a false start. As a result, many distributors spent the rest of the year getting rid of product by cutting prices and profit margins. Because distributors are loath to get burned again, they are approaching this year's good start with caution.

But, with good first-quarter results from the computer industry, there is every reason to believe this year will be different from 1986. Distributors' bookings and shipments grew by 6% between the fourth quarter of 1986 and the first quarter of 1987, reports Toby Mack, president of the National Electronic Distributors Association (NEDA). And the Semiconductor Industry Association reports that monthly semiconductor book-to-bill ratios rose continuously from October 1986 through March of this year.

Andrew Neff, an analyst with Montgomery Securities in San Francisco, Calif., believes that the distribution industry will grow at an annual rate of 11% or 12% in 1987, from $6.3 billion in 1986 to about $7 billion this year. Neff speculates that much of that growth will be driven by the 32-bit microprocessor revolution, much like the personal computer drove the last electronics boom. He is convinced that the early 1987 upturn in business reflects a real recovery by the computer industry and is not just a speculative buying spree.

Economic and technological changes will play a part in making this rebound a full-fledged recovery, says Mack, who is forecasting a modest but healthy 10% annual growth rate for the industry for 1987. The lower dollar, although having only a limited impact on the trade deficit to date, is expected to have positive consequences as the year progresses. Equally important to distributors is how quickly the new 32-bit microprocessor will become a mainstream component in their customers products. And, for the larger national distributors, the success of application-specific integrated circuits (ASICs) will play a role in their long-term economic health. Most of these effects, however, have yet to materialize.

Distribution

Sales by segment ($ billions)

	1983	1984	1985	1986*	1987*	1988*
Semiconductors	$2.30	$3.40	$2.10	$2.20	$2.50	$2.85
Systems	0.95	1.25	1.40	1.80	2.10	2.45
Passives	1.20	1.23	1.20	1.24	1.29	1.33
Connectors	0.85	1.00	0.95	1.05	1.15	1.30
Total	**$5.30**	**$6.88**	**$5.65**	**$6.29**	**$7.04**	**$7.93**

*Estimate

Source: Montgomery Securities

Cautionary note

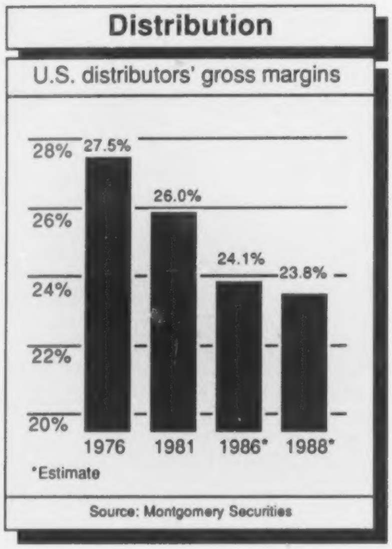
Anthony Hamilton, the West Coast-based chairman and chief executive of top-ranked Avnet Inc. and president of Hamilton/Avnet, is not as sanguine as either Mack or Neff: "It appears that the distribution business should grow at least 5% in calendar 1987 compared to 1986 with the strong possibility that for some firms it may be as high as 10% or more," he says. Avnet's sales are increasing "on a gentle basis."

Leon Machiz, the New York City-based president of both Avnet and Avnet's subsidiary Time Electronics, is more of an old guard optimist. He expects both Hamilton/Avnet and Time to post growth rates for the second half of 1987 of between 10% and 15%. He agrees that 1986 was "a false dawn" but says that the improvement in business so far this year is different. "I think we are witnessing a recovery," he says.

Hamilton believes the 1987 upturn in business is being driven partly by a real improvement in the market and partly by a concern for the future availability of Japanese semiconductors. The ongoing trade debacle between the United States and Japan is, indeed, a source of concern and is fueling speculative buying of commodity products. Contributing to this uncertainty was the franchise reshuffle of the top three domestic semiconductor makers late last year. Most industry watchers, however, believe the worst of the musical chairs franchise game is now over. But the ripple effects of these upheavals are still having an influence on short-term buying habits, and the trade war is not expected to subside.

"Business is up, but I wouldn't say it is a recovery yet," comments Bernard Marren, president of Western Microtechnology Inc., one of the few top 20 distributors that carries a full line of Japanese semiconductors. Although business has been improving since October, Marren is not convinced this is a substantial recovery because shipments have yet to catch up with bookings. "People are buying for futures more than for today."

Gordon Marshall, chairman and


Distribution

U.S. distributors' gross margins

Source: Montgomery Securities

president of eighth-ranked Marshall Industries, which also carries Japanese semiconductor lines, claims to have had a good first half, but he shies away from making forecasts. He believes one advantage to the trade dispute between Japan and the United States has been the stifling of the so-called gray market for foreign chips which frequently infiltrate the American market through unauthorized channels. (In theory, as the market price reaches the fair market value [FMV] — the floor price for Japanese products set during the trade negotiations last year — the grey market disappears.)

"We think we see some evidence that the grey market is slowing down," Marshall says, basing his opinion on what he hears from the street. Most people in the industry agree with Marshall that grey marketeers are having a tough time, but like most illicit operations, there are no statistics to back up the claims. But as the grey market dries up, the legitimate distributors that carry Japanese lines benefit. "The prospects look fairly healthy for Japanese DRAM sales through [franchised] distribution," comments NEDA's Mack.

OEM bookings

Marshall says that business has been picking up since October and insists that the market is experiencing the beginning of the long-awaited recovery. The force behind the upturn, he says, is the stronger original equipment manufacturer (OEM) bookings, the relative good health of the personal computer and peripherals market, and the overall improvement in business. He admits, however, that the recovery is still "spotty."

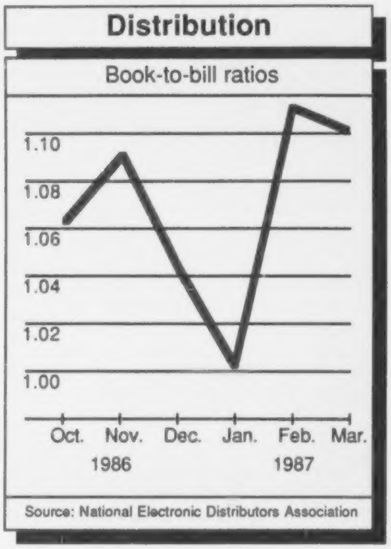
The fastest growing segments for distributors, comments Avnet's Hamilton, are in computer systems and ASICs. Semiconductors will also grow nicely for the balance of 1987, he adds. Machiz insists it will be the 32-bit microprocessor that will drive the recovery in the short term. Most distributors agree that all of these areas are expected to exhibit healthy growth. The military market, although somewhat saturated by increased distributor competition, is also expected to post respectable growth for the remainder of the year.

Stephen Kaufman, president and chief executive of Melville, New York-based Arrow Electronics Inc., the second largest national distributor, reports sales growth for the first calendar quarter of 1987 at a "satisfying" 12%. Although net income is still in the red, Kaufman claims that Arrow is now in the black with its operating income. Arrow's second quarter is expected to show sales growth of between 8% and 10%, he says, whereas the third quarter will be flat and the fourth quarter will be strong. Kaufman, like many of his optimistic competitors, believes that 1988 will be a very good year.

But some are not so easily convinced that the recovery is real. Clarke Walser, a senior vice president with The Chicago Corp., which tracks the distribution industry, says that despite the continued upward trend in sales over the past couple of quarters, he is concerned by the continued pressure on prices and gross profit margins. "I am more encouraged by what I see and hear out there today than I have been for a couple of years, but I think the proof has yet to be shown that this [recovery] is real," he says.

In the tank

This lack of evidence is reflected in distributors' persistent low prices, disappointing inventory turns and sorry gross margins. Prices and gross margins are still "in the tank," says NEDA's Mack, and are at a level that "we can expect to live with for the foreseeable future." Arrow's Kaufman agrees that prices and margins are still "very depressed" but he expects some improvement in the near term. Machiz, on the other hand, believes that prices have already bottomed out in some RAM chips and other commodity semiconductor products.


Distribution

Book-to-bill ratios

Source: National Electronic Distributors Association

According to Donald Lupfer, director of distribution for North America for the Electronic Components Group at TRW Inc., prices have continued to erode and distributors' gross margins are razor thin. Lupfer says TRW's ECG sells about $80 million worth of semiconductors, connectors and electromechanical devices to distributors. "I do not think we are out of the woods yet by any stretch of the imagination," he says.

One sign of health, however, is that leadtimes are starting to extend, Lupfer comments. Even though TRW had a strong first half of 1987, he concedes that the third quarter is traditionally slow. "I am satisfied that we are building some backlog and most of our deliveries are stretched out," he says. TRW's leadtimes are creeping out from an average of six to eight weeks to eight to 12 weeks for components; and 12 to 18 weeks for some connectors. He contends that the worst of the three-year dip is over. "People are a little bit more relaxed and a little bit smarter," he says.

Rosmarie Teaters, purchasing manager for Distributed Logic Corp. (DiLog), an Anaheim, California-based company, says she is hearing rumors that prices are on the rise and fears an overreaction from the purchasing community. DiLog, a $20 million company, purchases $3 million worth of semiconductors through distribution a year. "Unfortunately, the electronics industry is so rumor-oriented, it just boggles the mind," she adds, referring to issues such as the Japanese-U.S. trade war that could set off a round of speculative buying. But, for the most part, she expects prices to remain fairly stable. "I am keeping my fingers crossed that [the buying community] is more mature and that no one is going to overreact to rumors," she says.

Walser at The Chicago Corp. is concerned that if prices, gross margins and distributors' inventory turns do not start increasing soon, then many distributors will suffer when the recovery hits with full force. He estimates that the average distributor only has inventory turns of three times a year: a figure verified by many distributors. With gross profit margins in the low 20% range, he claims that no distributor can earn a satisfactory rate of return on their inventory investments.

As a result, many distributors are finding that they are financially hard pressed when it comes time to build inventory levels to satisfy increasing demand. "I think the industry is faced with a situation where it may well be unable to respond to a resumption of market growth because it doesn't have the capital," Walser warns. As for what might be in store for distributors, he believes that if inventories balloon but gross margins and inventory turns remain depressed, then this recovery could be just another flash in the pan. However, if both gross margins and inventory turns improve, it would be a sign that the recovery is real. ☐

OUTLOOK UPDATE

BY NORM ALSTER

Telecommunications: Market share is still up for grabs

In almost every segment of the telecom industry, the vendor base has expanded faster than the customer base

AT&T's first quarter report sets the tone for the telecommunications industry in 1987. Yes, when your comparison is with a dismal 1986 first quarter and when you are well into cutting 32,000 names off your payroll, you can show a 25% increase in profits. But no, lower head counts and trimmer tax bills cannot mask the reality of soft demand. AT&T's revenue fell nearly 7% during the first three months of the year. With needed standards for voice/data networks still a blurred and distant target and with loss-plagued competitors desperately hacking prices, large telecommunications equipment companies will depend increasingly on lowered costs. Revenue expansion will not come easy.

Overall, the telecommunications industry is expected to grow by 6% this year, from $142.4 billion to $151 billion, according to International Data Corp. Transmission services such as those provided by AT&T, MCI, US Sprint and regional Bell Operating Companies constitute 87.2% of that sum and with a 6% growth rate essentially dictate the overall market growth rate. Datacommunications equipment, at 3.3% the smallest share of the market, should be the liveliest sector, skipping ahead at a youthful 20% gait. But telecommunications equipment, which includes big-ticket hardware items like central office (CO) switches and private branch exchanges (PBXs), exhibits signs of premature aging, limping along at an estimated 2.8% rate of growth.

The dismal fundamentals of this industry are reflected in three major product sectors — CO switches, PBXs and T-1 multiplexers. In only one of these sectors — T-1 equipment — is the market in an energetic expansion phase. But in all three sectors, the vendor base appears to have grown faster than the customer base.

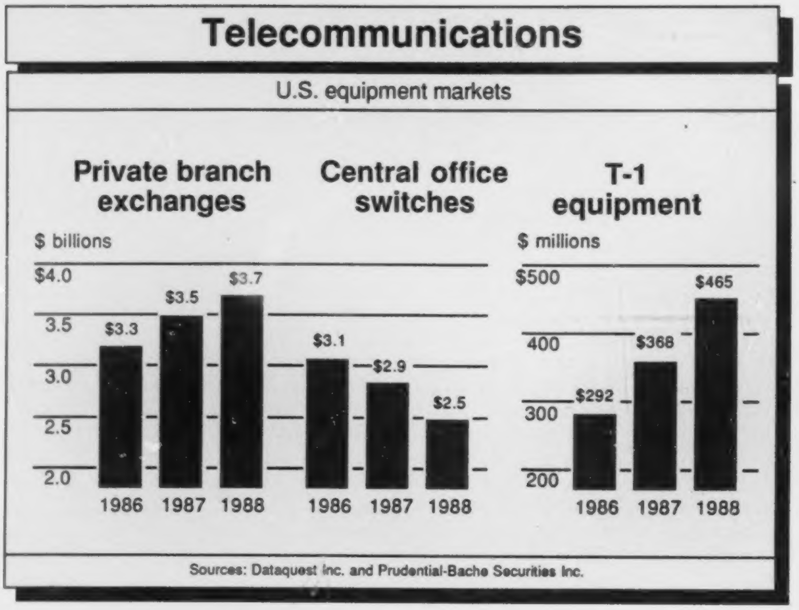
The PBX environment is especially glum. Harry Rosenthal, telecommunications equipment analyst for Prudential-Bache Securities, says pricing competition among PBX vendors has degenerated into "murderous warfare." Rosenthal estimates that the regional Bell Operating Companies, which act as distributors for such PBX manufacturers as AT&T, Mitel, Northern Telecom and Rolm, lost between $500 million and $1 billion last year.

PBX vendors are faced with a variety of problems. For one thing, the shift from analog to digital systems, a driving force in market expansion two or three years ago, is losing steam. Digital PBXs already account for more than half the installed base. PBXs have also suffered from the repeal of the investment tax credit and the loss of accelerated depreciation in the Tax Reform Act of 1986, says Glenn Powers, senior analyst with Northern Business Information (NBI). The loss of accelerated depreciation hurts PBX vendors more than central switch vendors. The telephone companies that buy office switches can only depreciate at regulated rates, generally 5% a year for 20 years. But private customers would typically depreciate PBXs over seven years, often front-loading the benefits to the first two or three years. The loss of accelerated depreciation makes rapid equipment replacement a less attractive option.

PBX problems

PBXs are also being hurt to some extent by central office switches, according to David Rubin, senior telecommunications consultant with Arthur D. Little, Inc. Until recently, explains Rubin, PBXs were able to offer corporate customers more sophisticated network features than those available through central office switches. But the emergence of Centrex software, which allocates a portion of the central switch to a single private user, has created greater feature parity and siphoned off some PBX demand. NBI's Powers says that Centrex-based services grew by 6% in 1986 and "depressed demand for PBXs slightly."

One of the few bright spots in the PBX industry is long-suffering Mitel Corp. Coming off three years of losses, problems in developing its high-end digital switch, and the termination of a strategic partnership by IBM, Mitel has managed a modest rebound. Sales for the nine-month period that ended Dec. 31, 1986 were $338 million, up from $303 million for the correspond-



Sources: Dataquest Inc. and Prudential-Bache Securities Inc.

ing three quarters of the preceding year. Industry observers credit British Telecommunications Plc's purchase of a controlling (51%) interest in the troubled supplier with reassuring customers that Mitel has the resources to continue in the business.

Arthur Franks, assistant vice president of U.S. marketing for Mitel contends that "installed base churning" should be enough to power 6% growth in the U.S. PBX market over the next three years. But Pru-Bache's Rosenthal expects the pricing environment to get uglier as money-losing manufacturers and their distributors seek to administer knockout blows to their rivals.

Like the conversion of analog to digital PBXs, the conversion from electromechanical to electronic CO switches is losing steam. Meanwhile, the conversion from analog electronic to digital electronic CO switches has not yet heated up. Less than 20% of the installed central office switch base at regional operating companies, has been converted from analog to digital, according to Van Cullens, vice president for marketing for Stromberg-Carlson Corp., a subsidiary of Britain's Plessey Co.

With Integrated Services Digital Network (ISDN) standards and implementations still evolving, many operating companies have chosen to wait before going digital. Today, says Anthony Costanzo, market development manager for Ericsson Network Switching Systems in Richardson, Texas, roughly half of 110 million to 120 million access lines in the United States are served by feature-rich analog switches: AT&T's 1ESS and 1AESS machines. Vendors of digital switches will have a hard time matching such features until 1990 or 1991, according to Cullens. Noting that 11.8 million lines were shipped in the United States in 1986, Cullens expects the installation of new CO lines to decline over the next three years to annual rates between eight million and 10 million lines. Dataquest Inc. and Prudential-Bache expect the CO market to contract to $2.5 billion by 1988, down from $3.1 billion last year.

Waning demand, along with the market-cracking efforts of foreign-based firms like Ericsson, NEC, Seimens and Stromberg-Carlson all point to a brutal showdown in pricing. Until the shift to digital picks up around 1990, the foreign firms will be trying to cut deals with the telephone companies to win a foothold for their switch products, developed at costs of hundreds of millions of dollars. The most ominous assessment of the situation comes from Glenn Powers of NBI. "It's a very long-term investment," he says of the European and Japanese firms that have rewritten their code for U.S. switch markets. "None of the companies are here in the short term to make money." Attitudes like that can have nasty implications for the competition.

Switched-on markets

Switch markets may be on hold for now but customers are still looking for ways to reduce the costs of communication. Such savings are a major factor in the growing popularity of multiplexer-based T-1 transmission services.

As large users take advantage of the savings from sending voice and data over private digital lines, sales of multiplexers for T-1 services should expand by 30% to 40% this year, according to Richard Villars, senior market analyst at International Data. T-1 services, which are provided by AT&T, MCI, US Sprint and some of the local operating companies, offer 24-channel lines for high-speed (1.544 million bits per second) digital transmission of voice and data. According to IDC's Villars, a single 24-channel T-1 line generally costs the equivalent of renting four or five public-switched transmission lines.

John Gordon, manager of telecommunications for United Fruit Co., says that his firm has pretty much finished buying PBXs for now, having purchased six systems from Rolm in recent years to replace older rented switches from AT&T. Now United Fruit is looking at the T1 option. The company currently has 20 WATS lines at its corporate facilities in New York City. The monthly bill for these lines, says Gordon, runs between $15,000 and $20,000. Gordon says that his company does not have the high volumes of data traffic that often make T1 services irresistible. Still, he says, the replacement of the WATS lines with a T1 carrier is now under consideration.

T-1 equipment, a $292 million market in 1986, should reach $368 million this year and $465 million in 1988, according to data jointly researched by Dataquest Inc. and Prudential Bache. T-1 multiplexer market leaders include Timeplex Inc., Network Equipment Technologies, General DataComm Inc. and Digital Communications Associates Inc.

But dozens of new vendors and new products boasting ever more efficient voice and data compression (thereby increasing bandwidth) are crashing the only fun party in the industry. Customers' dance cards are becoming very crowded. Thus, Merrill Lynch's interest in purchasing 200 T-1 multiplexers before the end of the year has already triggered "a bidding war" among courting vendors, according to IDC's Villars. "In T-1, the shakeout is beginning," concludes Rosenthal of Prudential-Bache. A.D. Little's Rubin suggests another threat. He expects AT&T to "make a pretty strong comeback" in offering new data networking services later this year that duplicate the efficiency of T-1 and other private networks. ☐

Utilizing AI in electronics manufacturing

Hitachi and Fujitsu are two companies which are pioneering artificial intelligence applications in Japanese factories

In the use of artificial intelligence (AI) for manufacturing, the electrical machinery manufacturing, which includes the computer and electronic equipment, continues to lead the way in Japan. That's the conclusion of a recent survey by the AI Demand Subcommittee, a group affiliated with the AI Vision Committee which, in turn, is jointly run by the Institute for New Generation Computer Technology (ICOT) and the Japan Information Processing Development Center.

Expert systems, the most frequently cited form of AI, are most frequently used in two types of departments, the survey indicated: development and design; and production control. In the former category, expert system applications include the design and development of everything from large-scale integration circuits, to switching power supplies, to die-cast process design, to computer room layout. In the production control area, the chief applications include solving problems related to ion injection in semiconductor manufacturing, diagnosing communications equipment failure, scheduling of resource allocation in a computer environment and manufacturing process control.

At the same time, marketing departments at many multinational companies are using expert systems to configure large-sized computer systems, as well as large-scale inductive electric motors. In addition, expert systems are used by engineering management to develop proposals for the various user systems. And administration departments are even employing expert systems to determine the correct protocol for welcoming visitors to the company, depending on their title and the nature of the business which they wish to discuss.

In addition, technical publishing departments at these high-tech firms are also developing machine translation systems, another form of AI, for translating manuals, patents and other multilingual kinds of paperwork.

Expert systems, too, are increasingly being used in graphics and image processing. Production and control departments, for example, are now using AI techniques to check printed circuit board (PCB) patterns for malformations or misprints. Further downstream in the production process are so-called intelligent robots, which use AI to drill printed circuit boards or cluster control mechanisms in a factory environment.

Computerized applications

In the computer industry, Hitachi Ltd. and Fujitsu Ltd. are fairly representative of the intense amount of activity that is now occurring in major corporations throughout Japan.

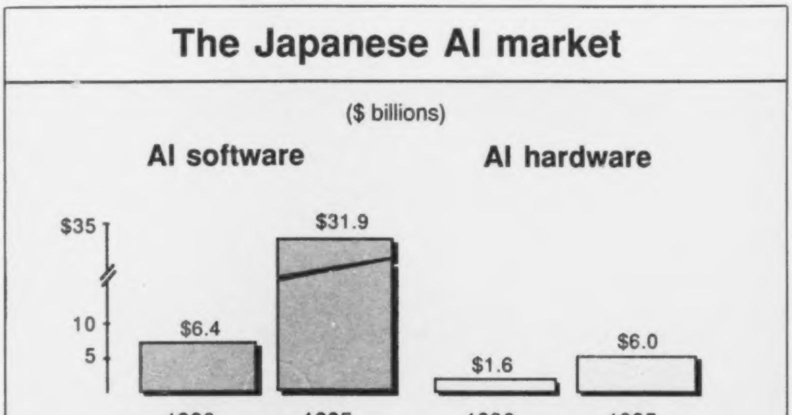
An insider at Hitachi has told ELECTRONIC BUSINESS that there are 120 AI projects now under development in his division alone. That tally also includes AI projects currently under development for customers. For customers in the nuclear industry, for example, Hitachi has already begun to use its in-house developed integrated nuclear plant computer-aided engineering (CAE) system in which, last year, it combined the techniques of atomic power plant design, manufacturing, knowledge engineering, and three-dimensional CAE/CAD computer graphics.

Hitachi is also said to have succeeded in developing production-oriented AI applications, including an automated materials-handling system for Kawasaki Steel. The on-line system reportedly allows nonprogrammers in a production floor environment to program equipment in one-third the time previously employed.

In still another application, Hitachi has devised an automatic train operation system for the Sendai City north-south rail line, which has been modeled after the operational procedures and ways of thinking used by skilled train operators.

Fujitsu also is heavily involved in AI. "We are promoting 75 projects within our computer division," one manager of AI development reports. The other computer divisions at Fujitsu, meanwhile, are running 75 additional operations. These applications include AI systems for production planning, material selection, technical consultation, design support and even ways to improve navigation. The multinational electronics firm has even built a computer-assisted scheduling system which incorporates 241 "if-then" rules (divided into 28 knowledge groups), 12 types and 218 LIPS (logic instructions per second) processing capability.

SHOHEI KURITA


The Japanese AI market

Sources: AI Subcommittee, AI Vision Committee, ICOT

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JULY 15, 1987

Electronic Business®

Foreign telecom vendors dial up U.S. sales

Bar codes: Keeping track in the factory

200
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The top 200 U.S. electronics corporations

VOL. 13, NO. 14

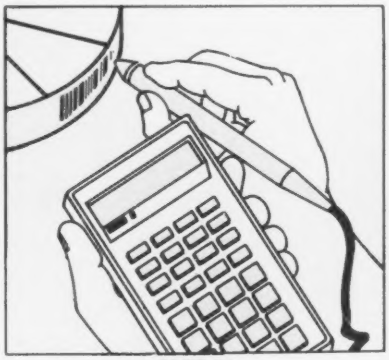
Electronic Business

JULY 15, 1987

THE BUSINESS MAGAZINE FOR THE ELECTRONICS INDUSTRY

PAGE 26

PAGE 55



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Communication equipment production picked up

AT&T gets control of its costs. Now, will the company benefit from the market's growth?

According to the Electronic Industries Association, U.S. factory sales of communication equipment in the first quarter of 1987 added up to $16.3 billion, an increase of 4% over the same quarter of last year. Judging by the much smaller growth that the U.S. Department of Commerce reports in industrial production of such equipment in the United States — only 1% for the same quarter — most of the increase must have come from sales of imported equipment.

AT&T, the largest domestic company in this market, offers a good example of the situation. All of its manufacturing is in the United States; therefore, it sees little of the market's growth. Indeed, the company's revenue went down in the first quarter by almost 7%. Net income went up 26%, "somewhat better than we expected," according to chairman James E. Olson, thanks to the cost reductions that began last year. But a major part of those reductions consisted of paring the workforce last year by 6% — more than 20,000 employees.

The EIA forecasts that U.S. sales of communication equipment will grow 4.5% this year. However, the association's previous forecasts underestimated the strength of this market in the U.S. in the past two years. The EIA had forecast the growth of the market for 1985 at half of the 18% it achieved, and predicted a decline of 2% for 1986, a year that sales increased by 13%. But, as it happened in the first quarter of 1987, it was foreign equipment that benefited from that growth. Industrial production of communication equipment in the United States grew by 8% in 1985 and stayed even in 1986. For 1987, Cahners Economics forecasts that production will grow 3%.

Then, there is the yen. At a remarkable strength of 140 yen to the dollar, 30% higher than last year, it would seem to make it very difficult for Japanese imports to reach the U.S. market. But, unless there is outright intervention of the U.S. government to bar imports of Japanese communication equipment, their penetration of the U.S. market may continue. Japanese communication manufacturers have emulated their automobile counterparts by estimating their production costs at 180 yen per dollar, even when it was over 200 yen per dollar. This has allowed them to absorb a major portion of the yen's increase in strength. But there is more.

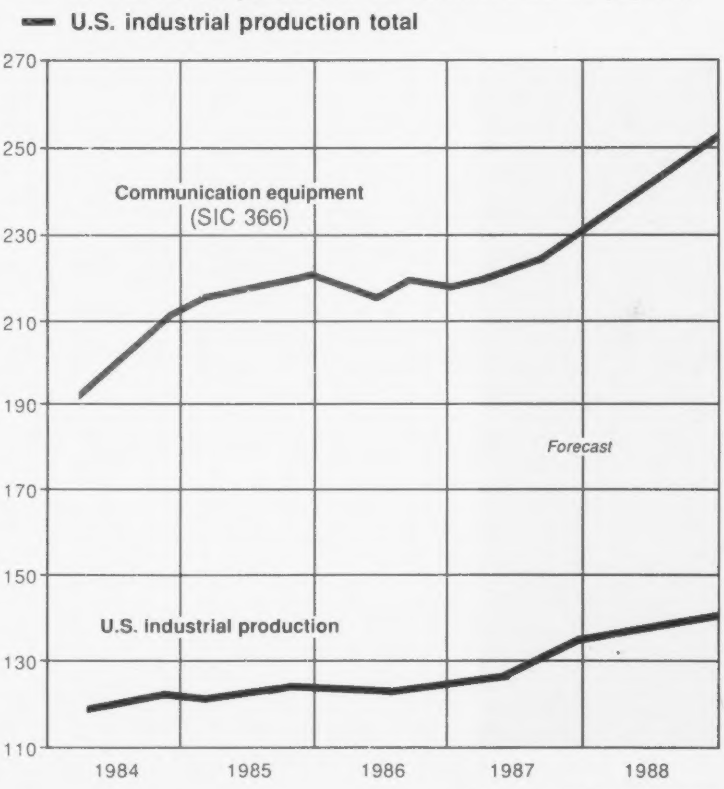
"While their major weapon in the past was price, today it is features. At the same time, Japanese companies are bringing in to the United States telephone products for the consumer, which incorporate many features that the more affluent consumers have learned to appreciate at their business offices and are eager to buy for their own homes.

For 1988, Cahners Economics forecasts 9% increase in domestic production. If U.S. manufacturers can get to market at the same time as the importers do with their features, the Cahners forecast may turn out to be conservative.

ALBERTO SOCOLOVSKY

Communication equipment

Industrial production indexes, 1977 = 100



Historical data: Federal Reserve Board
Forecast: Cahners Economics

Electronic components

Price trends within the electronic component market were somewhat mixed during the first quarter of 1987. In several product categories, including connectors and resistors, prices edged upward; in others, such as capacitors and some types of semiconductors, they dropped slightly. Industry-wide, prices decreased 0.2% in the first quarter, following an increase of 1.8% for all of 1986. Over the course of this year, as the business recovery gains steam and the U.S. rate of inflation picks up, manufacturers will gradually begin to raise prices. Prices are expected to climb 2.5% this year and 3.5% next year.

Capacitors

Capacitor prices dropped sharply in early 1987, after climbing for three consecutive quarters. In the first quarter, they averaged 1.8% lower than they did during the last quarter of 1986 and 1.3% below the year-earlier level. Mild upward price pressures are expected to resume during the rest of 1987, as demand increases from manufacturers of computers and other types of electronic-based equipment. Capacitor prices are expected to climb 0.8% this year and then post a further increase of 3.3% next year.

Connectors

Connector prices rose 1.8% in the first quarter of 1987, the biggest quarter-to-quarter spurt during the past two years. Over this period of time, manufacturers have felt the pressure of rising material costs, and prices have advanced continually each quarter at an increasing rate. In the next 12 months, as price competition from foreign suppliers eases off and the underlying rate of U.S. inflation pushes upward, the rise in prices is likely to accelerate. After climbing 3.5% in 1986, prices are forecast to jump 6.2% this year and 6.8% in 1988.

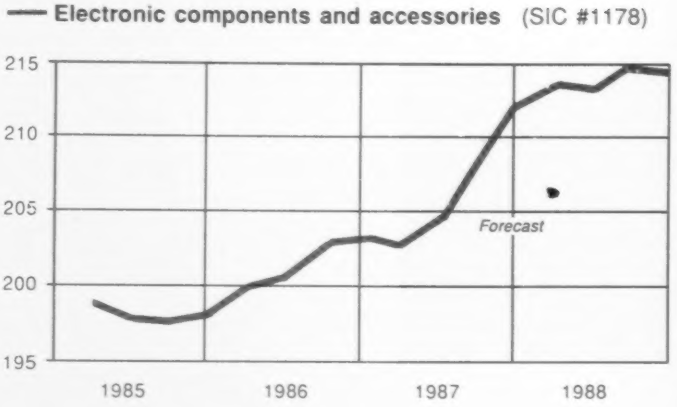
Resistors

Following three quarters of almost no increase in price, manufacturers of resistors started off the year by raising prices an average of 0.9% in the first quarter. The move was triggered by a sharp increase in orders during the period and by expectations of further steady improvements in demand from end users during mid-to-late 1987. After the first quarter's fairly substantial boost, prices are expected to rise at a less rapid pace through year-end, increasing only 1.1% annually. A more modest advance of 0.2% is expected next year.

Producer price indexes

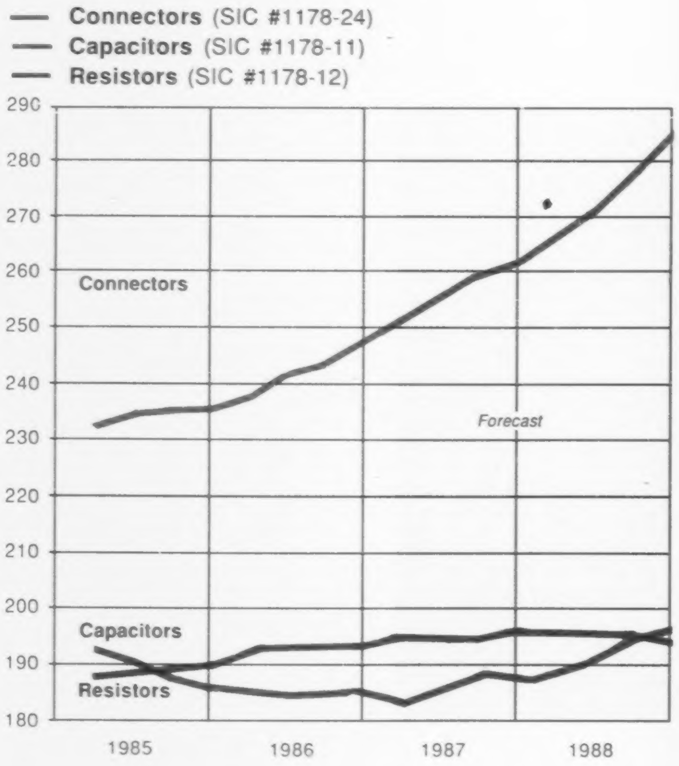
Electronic components

December 1967 = 100, quarterly averages



Passive components

December 1967 = 100, quarterly averages



Historical data: Bureau of Labor Statistics
Forecast: Cahners Economics

BUSINESS BAROMETER

Electrical machinery

New orders

Manufacturers of electrical machinery received $51.6 billion in new orders during the first quarter, a moderate decline from the fourth quarter's $54.4 billion figure and 1.8% below the year-ago quarter. This sluggishness was related almost entirely to a falloff in military procurement of communication equipment. All other segments were up from year-ago levels. The most substantial growth was for household appliances and lighting equipment; each up more than 15%. More modest gains were reported for electronic components, consumer goods and electrical apparatus. In light of the mixed performances, overall order growth should be a modest 4.8% this year and 14% more in 1988.

Unfilled orders

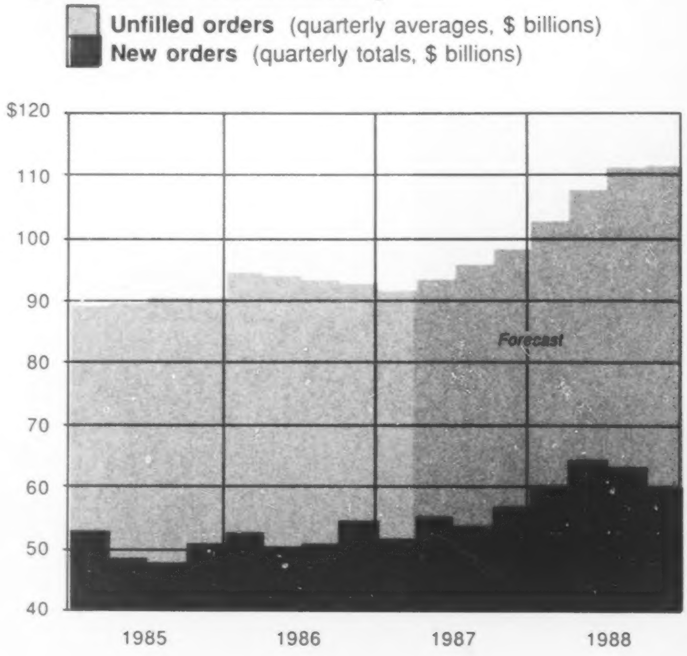
Last year's industrial sector decline and a cooling off in the defense boom have caused order growth in the electrical machinery market to slow markedly over the past 12 to 18 months. These developments have forced manufacturers to work down their order backlogs over the past several quarters in order to bolster production and revenue. By the end of the first quarter, unfilled orders fell to $91.26 billion, down from $94.31 billion in last year's first quarter. With nondefense orders now beginning to turn around, backlogs are expected to rise gradually over the balance of 1987.

Shipments

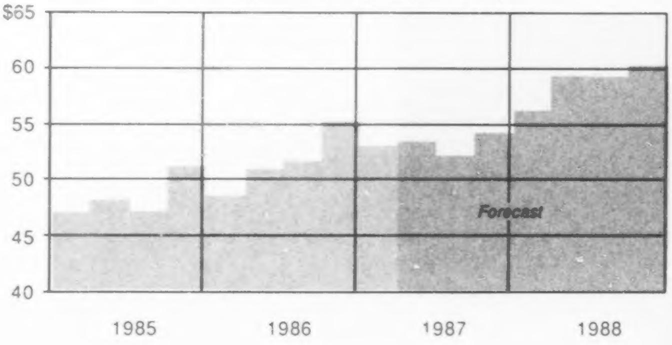
First-quarter shipments of electrical machinery amounted to $52.9 billion, an increase of 8.9% over the year-ago level. Growth was paced by the appliance and lighting equipment markets, where order activity has been unexpectedly strong in recent months. The electronic component and communication equipment segments grew only moderately, while electrical industrial apparatus, and TVs and radios barely outpaced a year ago. The recent slackening in defense orders is expected to restrain overall market growth, offsetting much of the improvement that is occurring elsewhere. This will hold 1987 shipments to $212.1 billion, a gain of 31%.

Inventory-to-shipment ratio

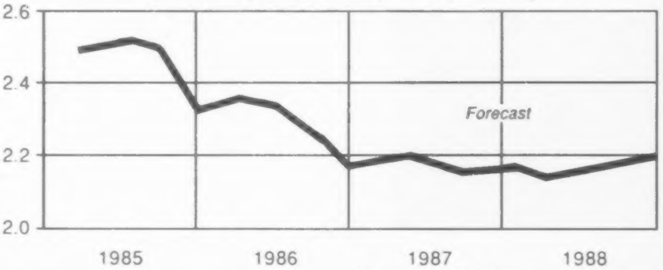
Between August 1986 and March 1987, electrical machinery manufacturers cut their inventories by nearly $640 million. This cost-cutting measure came hand in hand with slow but steady expansion in shipments. As a result, the level of industry inventories relative to shipments decreased slightly. The I/S ratio for this year's first quarter was 2.19, about even with the prior quarter but well below the peak of 2.50 in the spring of 1985. Manufacturers are expected to maintain tight control over inventories throughout the early stages of this expansion, keeping the ratio in a narrow target range of 2.15 to 2.20.



Electrical machinery: Shipments
(quarterly totals, $ billions)



Electrical machinery: Inventory-to-shipment ratio
(seasonally adjusted, quarterly averages)



Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

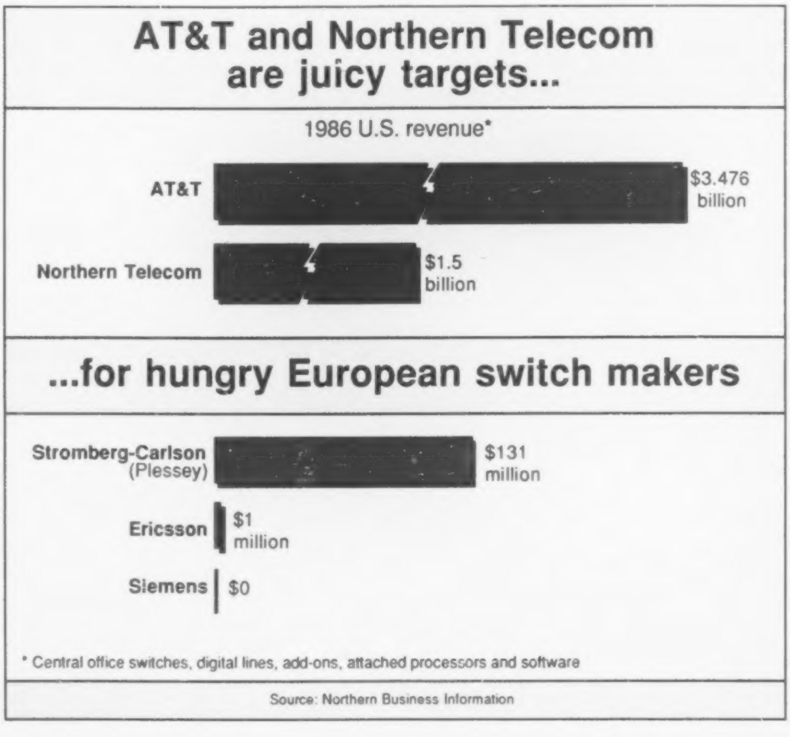
Taking on AT&T and Northern Telecom

Heirs to divestiture, Ericsson, Plessey and Siemens are starting to make inroads in the U.S. market

Somewhere between monopoly and oligopoly lies the domain of duopoly: the domination of a business by two sellers. The breakup of AT&T, along with the emergence of Northern Telecom, has left the central office switch market with two overwhelmingly dominant vendors accounting for close to 90% of all sales. Nobody is saying that this is a rigged market. But switch customers, chiefly the divested regional Bell operating companies (RBOCs) are determined that it never gets to that point.

To realize the benefits of greater price competition and to gain greater autonomy over software development, the RBOCs are encouraging the emergence of alternative switch suppliers. Chief beneficiaries of this customer revolt are a group of European vendors determined to unlock the U.S. market. In recent months, U.S. West, Bell South and Ameritech have awarded major switch contracts to Ericsson, Plessey and Siemens over their powerfully entrenched rivals. Further market-cracking awards are likely since six of the seven regional telephone giants are either testing or installing Class 5 central office switches from the Europeans.

"We think the price will be lower in a highly competitive market," Randall Corn of Bell South Services explains. "And with just two vendors — I would not describe that as highly competitive," adds Corn, who, as segment manager for fundamental network architecture, evaluates and purchases switching equipment for Bell South's operating companies.



AT&T and Northern Telecom are juicy targets...

1986 U.S. revenue*

...for hungry European switch makers

* Central office switches, digital lines, add-ons, attached processors and software

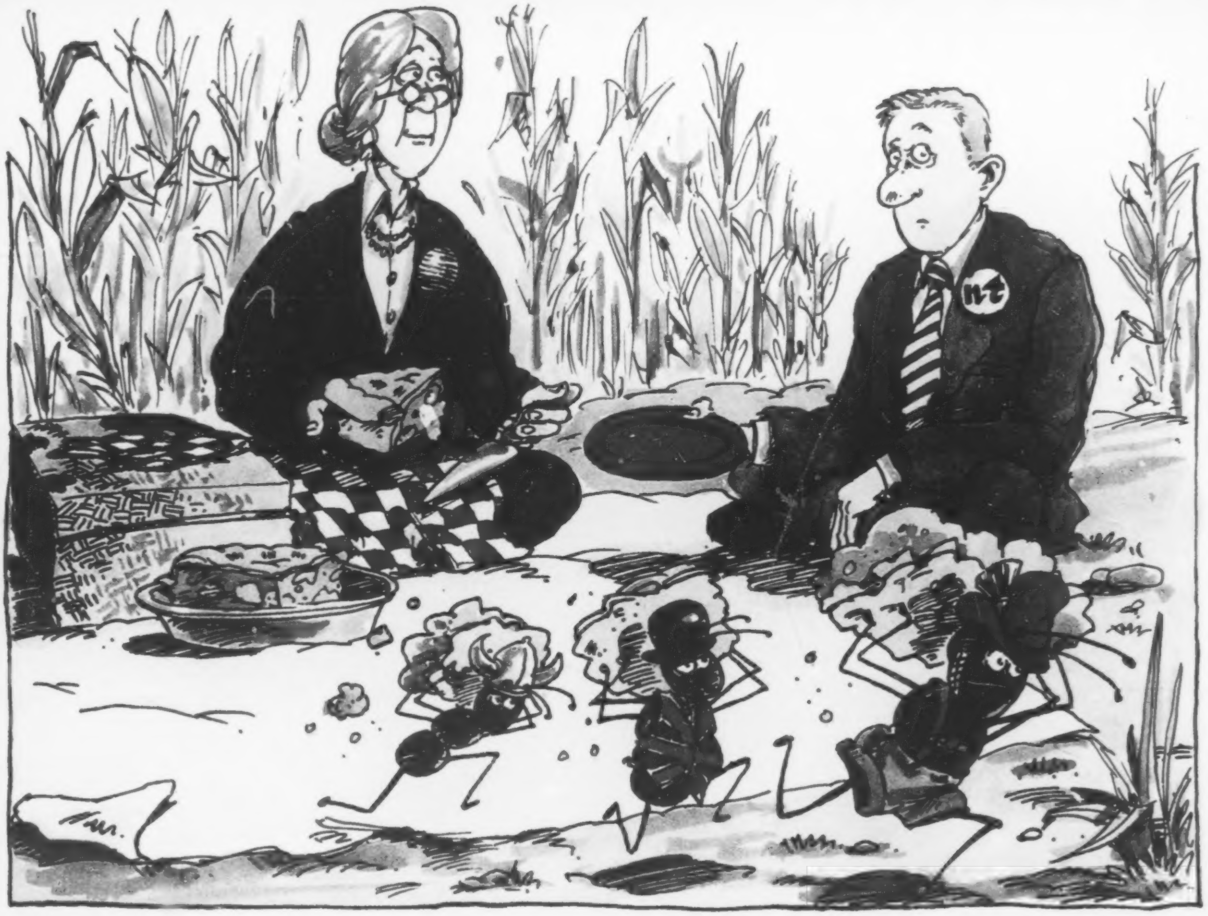
Source: Northern Business Information

"You've got two incumbents that have pretty much reached equilibrium in the marketplace," observes Van Cullens, vice president for marketing of Plessey Co.'s Stromberg-Carlson subsidiary. "I'm not implying at all that there would be any collusion," Cullens continues. "But I think it's the view of most of these [telephone operating] companies that at least three vendors are necessary to give you diversity of choice."

Stromberg-Carlson recently parlayed that desire for diversity into a 600,000-line order from Bell South valued by Cullens at "somewhere between $100 [million] and $200 million." Fifty-two central office switches handling 150,000 lines will be installed in rural areas of the South during the first year of the contract.

Another foreign-based duopoly-denter is Ericsson Network Switching Systems, a subsidiary of L.M. Ericsson of Sweden. U.S. West, in the process of converting from electromechanical switches to digital switches across the state of Idaho, recently awarded Ericsson a 50-switch contract over AT&T and other bidders. Anthony D. Costanzo, market development manager for Ericsson Network Systems, states that his firm's U.S. central office switch market-share objective is "12% to 15% by 1992." Then, perhaps still heady with the U.S. West victory, Costanzo quickly recalculates: "Well, by then we'd be at least 15%, probably more."

Last year, according to Prudential-Bache Securities Inc. and Dataquest Inc., the U.S. central office switch market was worth $3.1 billion. But this is a market that has begun to go the wrong way. This year, sales should sag to $2.9 million and in 1988 drop again, to $2.5 billion. Northern Business Information foresees the total number of digital local lines placed in service dropping from 10.5 million in 1986 to 8.1 million in 1989. With Ericsson, Siemens and Plessey (along with Japanese hopefuls like Fujitsu and NEC waiting in the wings) all desperate to recover multihundred million-dollar switch-development



Jon Mcintosh

costs and prove their ability to compete in the world's toughest market, things are likely to get ugly for AT&T and Northern Telecom.

Stiff upper lip

But for now at least, upper lips are stiffening. Jerry Johnson, AT&T's manager, product planning, digital switching equipment, expects the market share of the new vendors to "grow a little, but not significantly."

Alan G. Lutz, vice president for group operations of Northern Telecom's Integrated Network Systems division, concedes that the telephone companies "have a strong desire for a third source." He traces this tendency to the burdensome presence of RBOC-progenitor and authority-figure AT&T: The RBOCs, he argues, don't like buying switches from AT&T Technologies while AT&T Communications competes with their telephone services.

Lutz concedes that there has been substantial price deflation in the increasingly competitive switch business, but he claims that Northern Telecom is the low-cost producer and most likely to survive if price wars erupt. And Lutz maintains that the new vendors may find themselves in unpleasantly cold waters after the thrill of their early splash wears off. For one thing, he warns, the need for heavy investment does not end with product development. "They will only come to recognize that as they have a little bit of early success," Lutz says. The infrastructure investment in installation, service, technical assistance and customer training could overwhelm some of the new entrants, according to Lutz. "What do you do when a bank calls a telephone company and says: 'I don't like the service anymore because it doesn't work.' And the phone company calls the supplier and says: 'You have two days to rectify that.' And you only have three people in the United States."

Like ants at a picnic, Ericsson, Plessey and Siemens are sneaking away with bits and pieces of Ma Bell's and Northern Telecom's market

But, meanwhile, Ericsson and Stromberg-Carlson have shrewdly identified unmet market needs to win their "little bit of early success." Early market research convinced Stromberg-Carlson executives that they could concentrate on rural and suburban areas served by lower capacity switches. Ninety-four percent of all telephone central offices (accounting for 72% of all lines) require switches servicing 25,000 lines or less. And AT&T's solutions in this market sector were expensive, according to Cullers. Stromberg-Carlson decided to promote a switch architecture consisting of a relatively large number of small networked hosts. The company is touting this approach as better suited to rural phone company needs than systems based on large and powerful, but remote, hosts. With Bell South, this pitch — along with bare bones pricing — clearly worked.

"It was cheap," allows Bell South's Randall Corn in explaining the choice of Stromberg-Carlson. Corn said the Stromberg-Carlson switches, which typically handle 2,000 lines or less,do not offer the sophisticated software of larger switches. But, he adds, there isn't much demand for sophisticated business switch features in the rural areas of Alabama, Kentucky, Louisiana, Mississippi and Tennessee, which are the states that the Stromberg lines will service. Corn says that the Stromberg switches will fulfill less than half of Bell South's near-term switch replacement needs. In replacing some of its larger urban switches, Bell South would be unlikely to purchase the small Stromberg switches, Corn adds.

Software intensive

Price is not the only selling point for the duopoly-denters. The switch business, like the computer business, is becoming increasingly software intensive. And growing share of the switch revenue of AT&T and Northern come from software updates and new feature packages. But the telephone companies want greater independence in developing their own customized applications. Bell South's Corn, while emphasizing the sophistication of programming skills required to tweak central switch software, adds that software development "has been a problem with the established market participants."

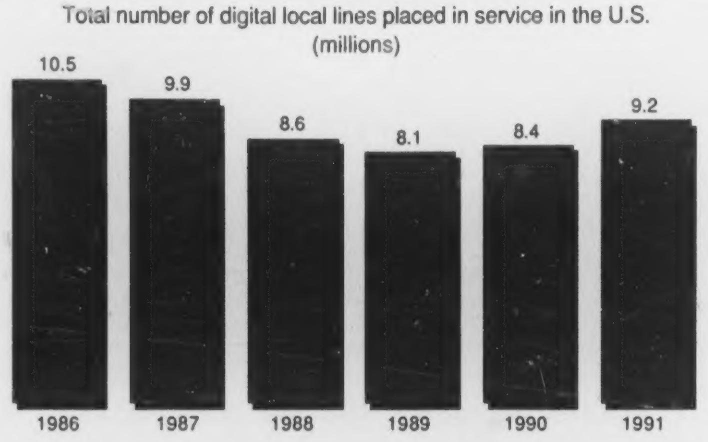
Would-be market participants have zeroed in on the opportunity. "Both Siemens and Ericsson have offered the telcos greater control in software development," says Glenn Powers, senior analyst with Northern Business Information. This, says Powers, has appeal for AT&T and Northern customers that "have no control over the product and the way software upgrades are made." Sometimes, says Powers, customers wanting a specific upgrade find they must purchase prior upgrades as well. AT&T's Johnson says that this is true but describes the cost of basic software updates as relatively modest.

Ericsson's Costanzo says that his company is offering the operating companies support in developing their own customized applications. "We have extended offers to the operating companies for them to have their design people work side by side with our design people in the preparation of new enhancements . . . . We provide the source code when we sell the switch . . . . To my knowledge, Ericsson is the only one that has made the source code available and has offered the RBOCs the opportunity to participate in software development."

> The Europeans know that the tests they face in selling against AT&T and Northern in the U.S. will soon be reenacted in their home markets

But Northern and AT&T are both sensitive to this marketing tack and appear to be responding in kind. "Software control is a desirable function from our customers' standpoint," Northern's Lutz acknowledges, "because it puts them in stronger control of the evolution of their own business." He says Northern is addressing that desire by working together with customer programmers in developing new code for customized features.

Telecommunications companies crowd into a sagging market



Source: Northern Business Information

Jerry Johnson, manager of product planning for digital switching equipment at AT&T, agrees that there has certainly been interest expressed by customers in developing their own applications. But, adds Johnson, there are some potential problems. If, for example, a customer writes its own code for customized features, what happens when AT&T issues one of its periodic systems software updates? What if the updates and the customer code don't work together? Who's responsible for insuring that they do? asks Johnson.

It appears that AT&T has the disadvantage of an incumbent here, trying to maintain software across a very broad customer base. Another interpretation of AT&T motives would be that it clearly enjoys the benefits (and profits) that issue from control of software development. In either event, it is not likely that AT&T and Northern, aware of customer desire for greater software development control, will allow Ericsson and others to win business on this point alone.

While AT&T and Northern Telecom face the unpleasant prospect of losing share in a shrinking market, the European companies are at substantial risk themselves. At a time when AT&T is aggressively trying to expand its own overseas switch sales; foreign telecommunications companies, which have long enjoyed the status of privileged government suppliers, are faced with the unfamiliar prospect of competition. The American telephone system is the biggest and the most sophisticated in the world, says Bell South's Corn. Siemens, Ericsson and Plessey are well aware that their home market hegemony is being challenged by the companies that have built that system. The Europeans know that the tests they face in selling against AT&T and Northern in the United States will soon be reenacted — for higher stakes — in the markets that they have monopolized, duopolized, oligopolized.

Meawhile, if the RBOCs have their way in the United States, duonoly will be averted. The regional phone giants would undoubtedly prefer to see an oligopsony. That is: a market where a small number of influential buyers call the shots.

NORM ALSTER

Bar coding: Scanning a $1 billion business

Demand for industrial bar code equipment is driven by a need for efficiency. It's all part of the JIT/CIM evolution

By Bruce C.P. Rayner

The automatic identification market is riding high on the crest of the automation wave. Bar-coding systems, representing about 85% of the auto ID market, are gaining converts in industrial applications as more and more companies realize the cost and efficiency advantages. For the auto ID industry this means good pickings for at least the next five years, with most of the business coming from industrial applications.

According to Edward Ross, president of Ross Associates Inc., a Needham, Massachusetts-based market research firm, the total bar code market in 1986 was $511 million and is expected to grow to over $1 billion by 1990 at an annual rate of 19%. On the more optimistic side, Frost and Sullivan Inc., a New York City-based market research firm, estimates the 1986 bar code market at $750 million and anticipates a 30% annual growth rate through 1990 when the market will reach $2.3 billion.

In essence, there are three components of any bar code system: the label that is attached to the item that is being monitored; the reader or scanner that records the information on the label or tag and sends it to the computer database; and the printer that prints out the labels. Of the five or six primary bar code symbologies, the most widely accepted in the industrial market is Code 39.

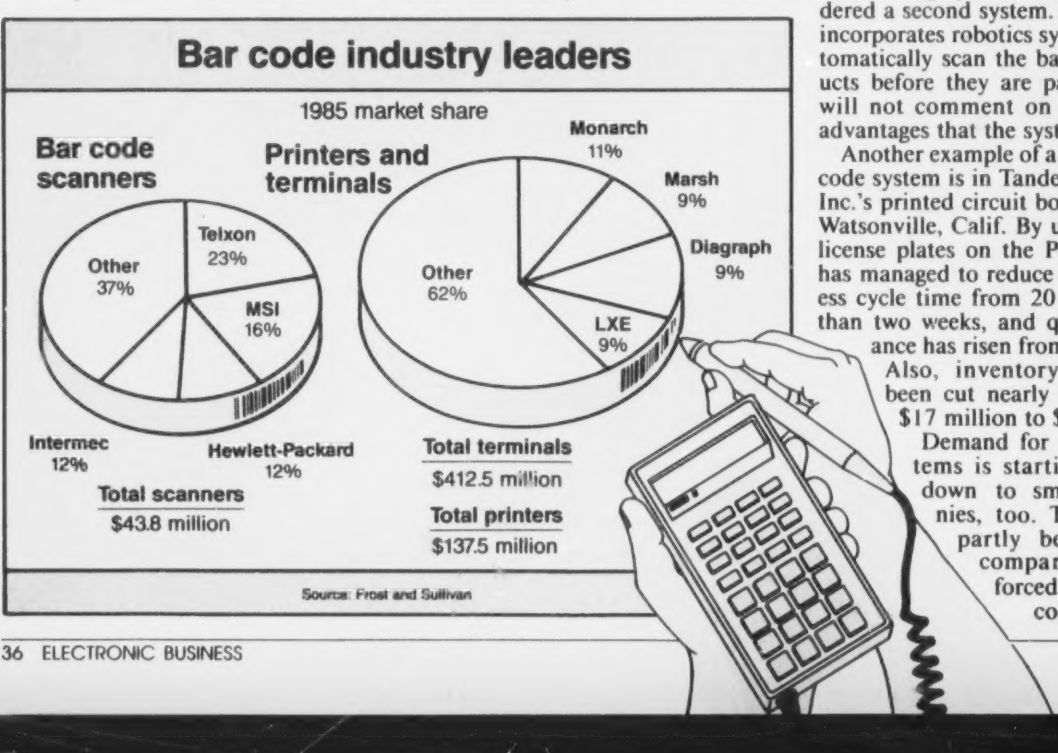
In some industries, unresolved standardization issues are preventing automation from taking off. Not so in bar coding. Although Code 39 is the de facto industry standard, most readers have the potential to "autodiscriminate" between a number of different symbologies.

To date, most of the demand for automatic ID systems has come from large corporations that feel the full effects of offshore competition. With the need to improve efficiency to remain competitive, many industry leaders, particularly in electronics, have incorporated bar-coding systems in their factories.

IBM's packaging line for electronic components in Research Triangle Park, N.C., is a good example of a highly automated packaging-inventory management system. As a part of this system, an automatic labeling system was installed at the facility by York Tape and Label Corp. of York, Pa., in 1985. Because of the success of the labeling system, IBM has just ordered a second system. IBM's facility incorporates robotics systems that automatically scan the bar-coded products before they are packaged. IBM will not comment on the financial advantages that the system provides.

Another example of a successful bar code system is in Tandem Computers Inc.'s printed circuit board facility in Watsonville, Calif. By using bar code license plates on the PCBs, Tandem has managed to reduce work-in-process cycle time from 20 weeks to less than two weeks, and quality acceptance has risen from 80% to 93%. Also, inventory levels have been cut nearly in half, from $17 million to $9 million.

Demand for bar code systems is starting to trickle down to smaller companies, too. This trend is partly because these companies are often forced to adopt bar coding because


Bar code industry leaders

Source: Frost and Sullivan

they are suppliers to large original equipment manufacturers (OEMs). This is the case for the automotive and electronics industries, as well as for suppliers to the U.S. Department of Defense.

Even though a supplier's initial reaction to the bar-coding system may be negative, the end result is invariably positive. Estimates of the payback period for a bar code system range between eight months and 18 months. The savings from auto ID systems come mainly from improved inventory management, better work-in-process control and more accurate shipping and receiving records.

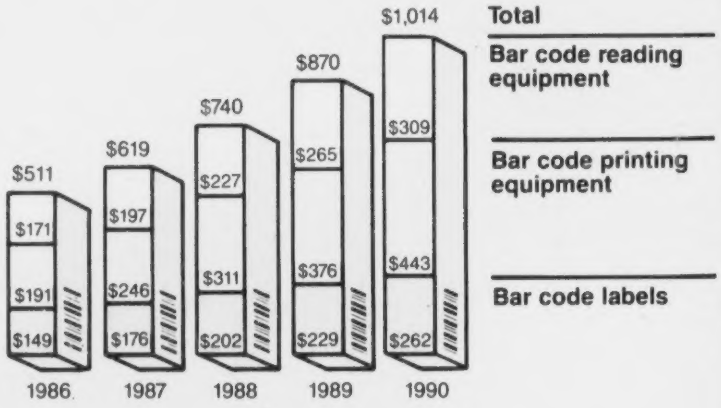
But, more important in the long term, auto ID systems are an integral component in the overall philosophies of computer-integrated manufacturing (CIM) and just-in-time manufacturing (JIT). Bar coding ties in with an existing material requirements planning or manufacturing resource planning system — MRP or MRP II — and enhances management information systems (MIS).

Edward Coe, a senior manager in auto ID systems with Deloitte, Haskins & Sells based in Detroit, sees the bar code industry moving more toward systems solutions that tie directly into an alphabet soup (JIT-MRP-MIS-CIM) environment. Bar coding, says Coe, is leading the way into a new era of information management in a more distributed and decentralized framework.

The key to success in the bar code industry, says Coe, is the ability for companies to "put it all together." Instead of marketing one line of hardware or one software package, the big winners in the industry will be those companies that can offer the systems solution to customers' problems. Some of the leading companies in the

The U.S. bar code industry

Worldwide shipments by U.S. companies ($ millions)



Source: Ross Associates Inc.

Shipments of bar code equipment and labels

Reading equipment ($ millions)

	1986	1987	1988	1989	1990
Wands	$11.5	$12.5	$14.0	$16.5	$20.0
Laser types					
Hand-held	23.0	34.5	48.0	65.0	85.0
Fixed	17.0	24.0	34.0	47.5	65.0
Slot (retail)	76.0	76.0	76.0	74.5	71.0
Read electronics	43.5	50.0	55.0	61.5	68.0
Total	**$171.0**	**$197.0**	**$227.0**	**$265.0**	**$309.0**

Printing equipment ($ millions)

	1986	1987	1988	1989	1990
Form printers*	$ 87	$106	$129	$158	$192
Label printers	104	140	182	218	251
Total	**$191**	**$246**	**$311**	**$376**	**$443**

* Dot-matrix-computer type

Bar code labels ($ millions)

	1986	1987	1988	1989	1990
Photocomposition	$ 23	$ 25	$ 28	$ 27	$ 27
Card-type labels	43	53	66	83	104
Industrial labels	68	82	90	99	110
Film masters	15	16	18	20	21
Total	**$149**	**$176**	**$202**	**$229**	**$262**

Source: Ross Associates Inc.

industry are following Coe's recommendation.

"Most people want to buy a solution, not equipment," says Roger Palmer, vice president for product and market development at Intermec Inc., a $62-million Lynnwood, Washington-based bar code company. Intermec manufactures readers, printers, and communications and network devices. "We see ourselves as the data-collection or automatic-identification experts," he says. The company also resells equipment of other vendors. Since the early part of the decade, Intermec has targeted the industrial marketplace because, says Palmer, it is the most lucrative.

Similarly, such players as NCR Corp. and Hewlett-Packard Co., although not solely in the bar code business, also offer turnkey bar-coding solutions. HP sold over $50 million worth of peripheral bar code equipment last year, not including software. With project centers around the country, HP acts as a prime contractor for bar-coding systems. NCR did about $30 million in shop-floor turnkey systems as a systems integrator in 1986, says Jerry Webb, program manager for manufacturing systems in the product marketing division for NCR. The company, however, does not manufacture its own bar code equipment.

But market researcher Ross questions the sensibility of companies that want to be all things to all customers. He points to the poor condition of one-time market leader Computer Identics Corp. (CI) of Canton, Mass., that prides itself on being a systems company. CI fell on hard times a few years back and has hovered around $10 million in sales ever since. Even progressive Intermec, Ross claims, gains little from trying to cover the whole spectrum of products.

Instead, Ross points to up-and-coming specialist companies, such as Symbol Technologies Inc., as the players with successful business acumen. Symbol Technologies, a Bohemia, New York-based maker of laser scanners, sells to both distributors and OEMs, like IBM and NCR. President Ray Martino believes that the hand-held laser-scanner market is the fastest growing area in the industry. From $8.7 million sales in fiscal 1984 (ended July 30, 1984), Symbol Technologies expects to do $44.5 million in sales for fiscal 1987.

Two other well-managed and well-entrenched companies in the portable scanner market are Telxon Corp., located in Akron, Ohio; and MSI Data Corp., based in Costa Mesa, Calif. Both of them have been extremely successful in the marketplace, and both buy units from Symbol Technologies. Telxon's director of market research, Randall Veatch, says that the key to Telxon's success is its focus on vertical marketing. The $100 million company also does specialized systems that involve a high degree of customer service, he says.

Scanning change

When it comes to technological change, the bar-coding business is similar to other industries that are moving toward smaller, more powerful systems. The most significant implication that new technologies are having on the bar code industry is that they allow more distributed systems, higher accuracy and lower cost.

A good example of technological

Getting in the swim of things

Salmon are generally not known for their high-tech sophistication. That is, unless they are salmon that run in the Columbia and Snake rivers in the northwestern United States. In a project funded by the Bonneville Power Authority and conducted by the National Marine Fisheries Service, samples of smolts (young salmon) have been injected with radio frequency transponders — commonly called RF tags — in order to monitor their migration.

Since the project began in 1986, there has been nothing but rave reviews from everyone involved — including the salmon. Earl Prentice, fisheries research biologist with the NMFS, believes this pilot program has a bright future. There are no harmful effects on the fish and the equipment is working like a charm. "This is only the start of a very large program to use this tool," Prentice claims, confidently. He speculates that the application for RF tags in wildlife and marine tracking will be used all over the world in the near future.

RF tags are a spin-off from inventory monitoring technology used mainly in industrial applications such as warehousing and manufacturing. When the transponder attached to the item being tracked is activated by a transmitter, it sends off a unique signal that identifies it with a computer system. RF tags are used as alternatives for bar-coding systems in working environments where bar code labels would not survive.

The salmon tags, manufactured by Identification Devices Inc. of Boulder, Colo., cost about $5 apiece. When the fish are still in the hatcheries, the tags are injected into the body cavity with a hypodermic needle. Each tag has a unique code that identifies the salmon's species, age, where it was raised, and where it was released. This information is then fed into a central database.

When the fish are released into the two rivers and begin their migration toward the sea, they pass through a number of hydroelectric dams where the NMFS has set up recording equipment that "passively interrogate" the fish. The equipment includes coils placed in the water that send 400-kilohertz signals which activate 40kHz to 50kHz return signals from the transponders. This acts as a time stamp for each particular fish. The information is processed and then compared with the initial file that was established at the hatcheries.

The compiled data is used to make sure that none of the hydroelectric stations is interfering in the migration of the fish: a regulation mandated by the U.S. Congress in 1980. The data is also used to determine survival rates and the timing of fish compared with the flow of the river. Prentice estimates that about 23,000 fish have been tagged so far. There is room for upward of 34 billion of these unique tags available for this project.

Although not a typical application, RF tagging of fish is proving very successful. Compared with the traditional method of freeze branding, RF tagging allows the sample to be reduced by up to 95%. Also, the fish do not have to be handled after the initial injection and both accuracy and reliability of tracking are greatly improved. Prentice claims accuracy is higher than 99%. ☐

change is in laser scanners, a field in which Symbol Technologies is a leader. The big trend is laser diode scanners which are beginning to replace the more conventional helium-neon laser scanners. The advantage of diode scanners is that they use only about one-sixth the power supply that helium-neon lasers use and, therefore, are more portable and more powerful. With the extra space available in these handheld units, interface and decoding circuitry can then be stuffed inside, eliminating the need for separate interface units.

There is no argument that technological innovation is driving prices of hardware down. But some industry watchers speculate that because there are over 300 companies vying for a piece of the bar code market the increasing competition will drive prices down even further. Others contend that there is plenty of business to be had by all, and that no company has the clout to force price degradation. The latter seems to be the opinion held by the majority.

Coe, at Deloitte, Haskins & Sells, believes that prices are dropping as a result of technological innovation. He speculates, however, that as the industry matures, there will be a paring down in the number of companies in the market. Intermec's Palmer agrees: The industry will eventually move toward an oligopoly a few years down the road, he predicts.

Although bar coding is the primary method of automatic identification, other methods do exist. Most experts agree, however, that there is little chance of any technology replacing bar codes in the foreseeable future. One of the most notable technologies is the use of radio frequency transponders, commonly called RF tags. These are small systems, sometimes the size of a grain of rice, that, when activated by a transmitter, send a unique radio signal to a receiver.

The industrial marketplace offers the greatest potential for growth

RF tags are a logical choice for hostile industrial environments where bar codes would not survive; such as in automotive paint shops or in factory processes that subject products to extreme temperatures. An issue that is holding up the widespread use of RF tags is the problem of standardization. Without standards, production runs tend to be short and unit costs are correspondingly high. Compared with paper bar code labels that cost almost nothing, the cost of an RF tag ranges between a few dollars to as much as $50.

Although RF tags may never replace bar codes, independent management consultant John Gallagher contends that they do have a viable market. From a recent survey he conducted, one of the top three issues concerning bar codes was that they were not applicable to the respondents' industrial processes. Coe of Deloitte, Haskins & Sells agrees that RF tags have their place. He says that once standards are established there will be a drop in their unit cost and an explosion in their acceptance.

Currently, most RF tags are read-only, but progress is being made in the field of read-write tags. The advantage of a read-write tag is that it can carry its own database which can be updated periodically: an example of further decentralization. One possible application of read-write tags is in the automotive industry, where a tag would be attached to an engine block. Whenever the car is serviced, the mechanic can read the car's service history, and then update it after the check-up.

Reading the market

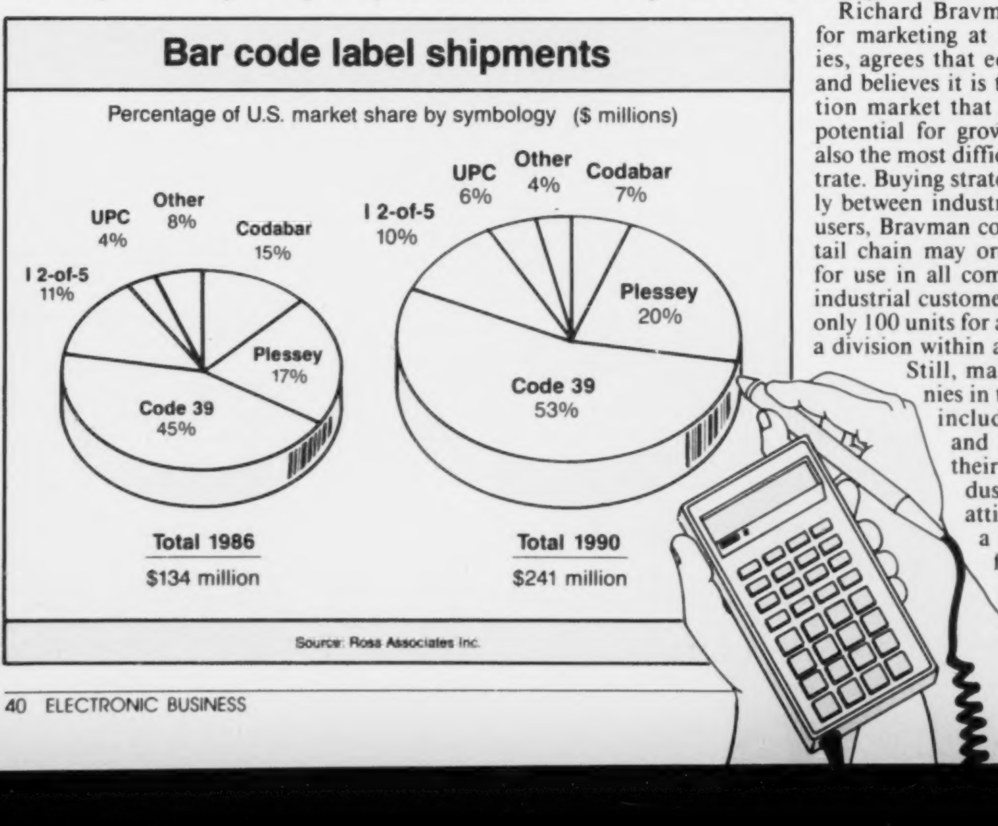
Most vendors and analysts agree that the industrial marketplace offers the greatest potential for growth. Industrial use of bar codes currently comprises less than 5% of potential factory applications, claims the Frost and Sullivan bar code report. Gallagher, who is the author of this study, contends that if this market is to enjoy the growth the industry seems to expect, then it must concentrate on educating the customer.

Richard Bravman, vice president for marketing at Symbol Technologies, agrees that education is crucial and believes it is the factory automation market that offers the greatest potential for growth. However, it is also the most difficult market to penetrate. Buying strategies differ markedly between industrial users and retail users, Bravman contends. While a retail chain may order 7,000 scanners for use in all company locations, an industrial customer will typically buy only 100 units for a particular plant or a division within a plant.

Still, many leading companies in the auto ID market, including HP, Intermec and NCR, are focusing their efforts on the industrial customer. The attitude is that it is just a matter of time before the manufacturing community wakes up to the benefits of bar coding. ☐

Bar code label shipments

Percentage of U.S. market share by symbology ($ millions)



Source: Ross Associates Inc.

The making of a military GaAs market

Commercial chip makers may be cautious about gallium arsenide, but military vendors foresee increased demand

By Valerie Rice

High-priced and temperamental gallium arsenide (GaAs) has found a home in the military market. While many commercial merchants have yet to make serious investments in GaAs, military suppliers are forging ahead, garnering the lion's share of the current GaAs market.

In 1986 total worldwide production of GaAs products (both merchant and captive, as well as pure R&D) was $2.4 billion and is projected to double by 1990, according to market research firm Henderson Associates, Los Altos, Calif. Of that total, military production (also including captive) represented $430 million in 1986 and will be $1 billion in 1990.

Looking at just integrated circuits, the GaAs worldwide market in 1986 was $240 million, of which 70% was military, according to Henderson Associates. By 1990, according to market research firm Mackintosh International, Luton, England, the military IC market will account for 58% of GaAs sales in the United States.

Although even GaAs fanatics concede that the current number of systems with GaAs parts is fairly small, the process is beginning to gain attention as a high-speed solution for phase array radar systems, electronic warfare systems, satellite and space-to-space communications, missile guidance and "smart" weaponry. Widespread acceptance in these areas will probably not happen until the early 1990s, but a number of companies are finding a large amount of business — particularly in research and development dollars — in the military GaAs arena.

Colorado Springs, Colorado-based Ford Microelectronics Inc. does about 80% of its GaAs business with the military, says GaAs marketing manager Charlotte Diener. Ford has also invested $33 million since dedicating a building to GaAs production in 1985, she says.

Watkins-Johnson Co., a military systems supplier and a captive producer of GaAs cannot even begin to quantify the investment made in GaAs, says vice president Keith Kennedy. The company has been in GaAs almost 20 years and has over 60 people involved in full-time development of GaAs products.

AT&T Bell Laboratories, Princeton, N.J., which just signed a $19.8 million deal with the Defense Advanced Research Projects Agency (DARPA) to make 4K dynamic RAMs, is very excited about GaAs, says compound semiconductor lab director Bernard Murphy, and the company is planning to sell its products on the merchant market in 1988.

> A large number of companies are finding a large amount of business in the military GaAs arena

As a relatively untried technology, GaAs was ripe for the picking. The question was, which side of the market would make the first move? Several years ago it appeared that the commercial market might forge ahead, but that short-lived burst of activity is now recognized as premature. Instead, the military market has quietly been encouraging its suppliers and putting its effort into two very different directions. The first is toward the development of digital GaAs, particularly static RAMs, and the second is the development of a program similar to very high speed integrated circuits (VHSICs) called MIMICs for monolithic millimeter and microwave integrated circuits, all to help GaAs gain a toehold in the market.

Grow your own

Although the technology is hard to work with, and relatively difficult to "grow your own," it has four properties that make the difficulties seem trivial. Most important, it has "blinding speed," as one GaAs executive describes it, and low power requirements. It is inherently more radiation-resistant than silicon, making it ideal for certain Strategic Defense Initiative

Worldwide GaAs merchant consumption forecast by technology

($ millions)

	1984	1985	1986	1987	1988	1989	1990
Analog ICs	$46	$80	$177	$173	$237	$313	$387
Digital ICs	11	26	61	17	216	352	585
Discrete optoelectronic	1,152	1,089	1,361	1,602	1,811	1,866	2,136
Integrated optoelectronic	8	20	28	43	67	104	162
Microwave transistors	122	156	210	273	341	410	450
Total	$1,339	$1,371	$1,777	$2,108	$2,672	$3,045	$3,720

Source: Dataquest Inc.

applications; and it can operate at much higher frequencies than anything else developed. All four of those properties make it invaluable to the military, says Ford's Diener. The commercial market, on the other hand, is probably only interested in the speed and maybe the power, she says, providing one clue as to why GaAs is so popular with the military.

"The only reason anybody would invest in another [process] material is because it gives you an advantage in parts," says Harris Corp. Semiconductor Division's GaAs operations vice president Joe Barrera. "The primary advantage is that you can build a variety of parts with different signals, higher speeds and frequency increases. GaAs has inherently higher speeds."

GaAs, surprisingly, is really not even a new technology to the military. Although recent applications are brand new, GaAs has been around in different incarnations for years. Harris, for example, has been supplying discrete field effect transistors (FETs) in GaAs since the late 1960s, and discrete FETs are still 60% of the company's business.

The latest GaAs development has been in the digital IC area. Bell Labs, Ford Microelectronics and Harris, to name a few, are all investing heavily in the push into digital ICs. Mackintosh analyst Kheldun Kahn says that the development of the digital and analog GaAs markets are quite different. "In digital there is nothing but start-ups," he says. "In analog, it is existing companies, who are active in special niche markets, some for as many as two decades. They are slowly evolving towards products. With digital it is more of a revolution in terms of technology. The takeoff is slow."

Some GaAs start-ups and products

Company	Digital ICs	Analog ICs	Opto-electronic	Field effect transistors
ABM Semiconductor San Jose, Calif.	NA	NA	Yes	NA
Anadigics Morristown, N.J.	Yes	Yes	No	NA
Celeritek San Jose, Calif.	Yes	NA	NA	Yes
Gain Electronics New York, N.Y.	NA	NA	NA	NA
Hittite Microwave Lexington, Mass.	Yes	NA	NA	NA
Isocom Campbell, Calif.	No	No	Yes	NA
ITT GaAs Technology Center Roanoke, Va.	Yes	NA	Yes	NA
Les Technologies OMVPE Quebec, Canada	No	No	No	No
Lytel Somerville, N.J.	NA	NA	Yes	NA
Microwave Technology Fremont, Calif.	Yes	NA	NA	Yes
Pacific Monolithics Sunnyvale, Calif.	Yes	NA	NA	NA
Plessey Three-Five Group Towcester, Northamptonshire, Britain	Yes	Yes	Yes	Yes
Sanders Associates Nashua, N.H.	Yes	NA	NA	NA
Techonics Bethpage, N.Y.	NA	NA	NA	NA
Triquint Semiconductor Beaverton, Ore.	Yes	Yes	NA	Yes
Vitesse Electronics Camarillo, Calif.	NA	Yes	NA	NA

NA — Not available

Source: Dataquest Inc.

A new breed

Harris' Barrera says that the new breed of GaAs digital ICs (Harris calls them "digics") are "meant to be emitter-coupled logic level compatible. They will do the same things but at [much] faster operation. For example, a GaAs part will have a 2-gigahertz clock rate versus a 10-megahertz clock rate for a similar silicon part."

Texas Instruments Inc. has internal digital capability at the present and is incorporating some digital products in its military group, but is waiting to see what the market brings before going merchant, says manager of microwave components Thomas Kilgo.

According to Kahn, waiting is not such a bad idea. "There has been a lot of hype in the GaAs market which is the result of proponents of the process characteristically underestimating the maturation cycle of GaAs. Users are finding it difficult to get parts, and vendors have underestimated the difficulty in development. Yields are very low."

One of the reasons yields are low is that the parts are very sensitive, Kahn says. He tells a story of one early-release GaAs part that had to be breathed on before it would run, and if it was fanned to cool it off, it would stop.

With the low yields come the high prices. The price of a typical hardware multiplier in GaAs can run between $300 and $400, while the same part in silicon CMOS, admittedly much slower, at $50, is seven to eight times cheaper, says Kahn. And silicon is not likely to go away, even if the prices of GaAs drop, says Bell Labs' Murphy. The technology that makes GaAs so fast also makes it impossible to use for DRAMs, certainly the cornerstone of silicon technology, and much of the IC-based electronics industry. So for the time being, silicon will retain its grip on the low-end military market while GaAs will be targeted at the high end.

One early DARPA-funded participant in digital GaAs has since discontinued its production. Honeywell Inc., Minneapolis, pulled out of the digital arena at the beginning of 1987, after reevaluating its internal needs, a spokeswoman said. The company had a dedicated plant in Richardson, Texas, which is currently being converted to other products. Honeywell is still servicing its military customers in the analog and photoelectronics areas. "Our internal need was predominantly for analog circuits in the aerospace and defense areas," the spokeswoman said. "The decision was purely a business one."

Yet despite the problems, there is pressure to generate product, Ford's Diener explains. "I know up until 1984 Japanese companies spent $300 million to $400 million on GaAs research. For that time the U.S. spent about a third of that, I would guess," she says.

Drunken sailors

"The Japanese are spending money like drunken sailors on GaAs," echoes consulting firm McKinsey & Company Inc. principal Robert J. Neely. "Each of the major companies is spending $50 million to $100 million per year."

"The Japanese companies are very good in GaAs. They have spent a lot of dollars and effort in this area," Dataquest Asian Service director Thomas Wang says. According to Wang, the Japanese are currently involved in developing very large scale integration (VLSI) GaAs chips for use in the supercomputer market.

The Japanese are currently involved in developing VLSI GaAs chips for use in the supercomputer market

Thomas Wang of Dataquest

Henderson Associates' Ken Taylor stresses that the Japanese are a threat in the military market, however, despite their internal concentration on digital products. According to Taylor, the Japanese virtually own the military satellite segment of the GaAs market, and the Defense Science Board is worried about this trend toward increasing dependence. "The Japanese have very good GaAs devices, and high tech military contractors are buying them and putting them in military products," Taylor says. "This is a major concern."

But the Japanese are not spending their efforts on defense development, but rather on more commercial products, Wang says. The Japanese companies are developing SRAMs predominantly for use in supercomputer.

"The companies who are working hardest on supercomputers are working hardest on GaAs," Neely stresses. Although a number of U.S. companies, including IBM, are working internally on GaAs development, Neely believes that it may be late in the game. "Folks like Cray don't have substantial in-house development to my knowledge; they can get into close partnerships, but they are not as far along as if they were doing it all internally. The smaller start-ups are way behind the Japanese."

Supercomputer solutions

The military push can't hurt GaAs development, Neely says, but the fact that it is not geared directly toward digital products may mean that the United States will have trouble catching up, particularly in the supercomputer market.

Wang believes, however, that in five years costs will drop, allowing the United States to move GaAs applications into a more broad-based commercial environment. In the meantime, only very large and speed-hungry U.S. companies, like Cray Research Inc., are delving into the world of GaAs digital products — primarily through a variety of U.S. GaAs subcontractors.

Despite some concerns surrounding digital products, the MIMIC program is moving strongly ahead. Historically, military GaAs solutions were hybrid combinations of packaging, microwave technology and transistors that often took up large amounts of space and required significant investments in time and testing. With the new MIMIC program, the push is on to offer a monolithic solution — that is, build up on a chip instead of out onto a larger surface area. The MIMIC program is structured with 12 contractor teams participating in a number of "phases" of study in an effort to increase the capabilities of GaAs circuits while reducing their size and cost.

For microwave applications, GaAs is the perfect solution for smaller surface areas, and less dollars in test and engineering, and higher reliability, says TI's Kilgo.

TI has been a captive supplier for a number of years and recently entered the merchant market with a limited number of design-ins for standard products. "Our business breaks down into hybrid technology and monolithic technology," Kilgo explains. "A large percentage has been hybrid technology, but we are going to bring to bear our monolithic technology on the market."

The largest problem, of course, is price. Monolithic products tend to compete not just with silicon, but with hybrid solutions containing silicon, Kilgo says. Also the nonrecurring expenses with monolithic products, particularly in the early stages, are much higher than with hybrids, even though the reliability is also much higher. However, this year TI will see its first product program for the Department of Defense, a monolithic-based component device, and Kilgo is optimistic that as yields and volume increase, prices will go down.

One group that has undoubtedly benefited from projects like the MIMIC program is semiconductor equipment manufacturers, which are now being called upon to develop sophisticated equipment to help manufacturers meet their customers' needs.

Only very large and speed-hungry U.S. companies are delving into the world of GaAs digital products

EmCor Corp., a South Plainfield, New Jersey-based manufacturer of GaAs equipment, has grown, thanks to the increase in government contracts for GaAs development, says finance and administration vice president Bernard L. Riley. "There are a number of government-funded programs and there certainly has been a positive impact in terms of an increased need for equipment for growing GaAs," Riley says.

According to Riley, the equipment market for GaAs is relatively small, somewhere between $25 million and $30 million, and there is a very small number of major players (four or five at the most). One of the reasons, Riley explains, is that the philosophy until around 1984 was for companies and research institutions to "build their own" equipment. Now, with the GaAs market expected to grow significantly in the next few years, Riley is expecting increased demand for equipment to keep up with the growth. ☐

Wiser, leaner and financially meaner

The U.S. electronics industry matured in 1986 when the battle of the bottom line became survival of fiscally fittest

**By Eric Lundquist
and Linda Stallmann**

The year of the bottom line. The year when companies displaying the best business acumen clearly outdistanced the technology worshippers. The year when a young industry turned the corner to maturity. The year when the ELECTRONIC BUSINESS 200, the financial gauge of the computer and electronics industry, saw revenue rise to $279.2 billion while net income fell to $26.7 billion. In 1986 the major U.S. electronics and computer companies which make up the ELECTRONIC BUSINESS 200 displayed all the woes that beset the boisterous industry, along with all the promise that a mature fiscal wisdom portends.

First, some facts. The ELECTRONIC BUSINESS 200 is an exclusive report by ELECTRONIC BUSINESS magazine analyzing the revenue of the 200 largest U.S.-based computer and electronics manufacturers. The report is based on a careful analysis of thousands of annual reports, interviews with company executives, and estimates developed internally at the magazine. As such, the 200 provides an accurate gauge of the current status and future direction of the U.S. electronics industry.

Change, which is always a constant in any vibrant industry, was especially evident in the 1986 ELECTRONIC BUSINESS 200 listings. Twenty-eight new companies joined the list replacing those U.S. firms that either merged, were taken over, or whose plummeting revenue drove them out of the 200 ranks. Software firms have now made their appearance as a separate product category. IBM, the perennial first place winner, continued to widen its revenue lead over the rest of the pack. The billion-dollar club, those 51 companies that command the industry, continued to show an even more commanding influence.

But, even though the revenue results position the winners, it is often the other categories' results that foretell the changes that will unfold over this year. The most obvious change, and one apparent in the income line, is that many companies spent 1986 cleaning up their bottom lines and taking the financial hits that were necessary to come out of a recession with a recharged balance sheet capable of mounting a market share assault. A second major change was the remarkable growth in importance of foreign revenue. It was foreign revenue that sustained many U.S. firms through the 1986 sales drought.

Each year we have a goal of increasing the amount of information that we provide in the 200 listing. This year, we met and surpassed our goal of continually expanding the 200. In addition to the tabular material that has made the ELECTRONIC BUSINESS 200 the most referenced electronics and computer company listing in the industry, we have provided profiles of the companies whose electronics sales have gained them admittance to the billion-dollar club. ☐

NEW COMPANIES IN THE 200

Company	Rank
ADC Telecommunications	186
Ametek	167
Anthem Electronics	198
Applied Magnetics	194
Ashton-Tate	141
Atari	115
Bolt Beranek and Newman	148
BRIntec	130
Data Card	175
Digital Communications	176
Genicom	174
Intelligent Systems	187
Lotus Development	106
Mark IV Industries	180
Maxtor	184
Micropolis	138
Microsoft	114
MiniScribe	158
Olin	199
Reynolds & Reynolds	132
Sun Chemical	191
Sun Microsystems	93
Textron	83
Thomas & Betts	200
UCCEL	188
Ultimate	172
Unisys	7
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THE 200 ON A DISK

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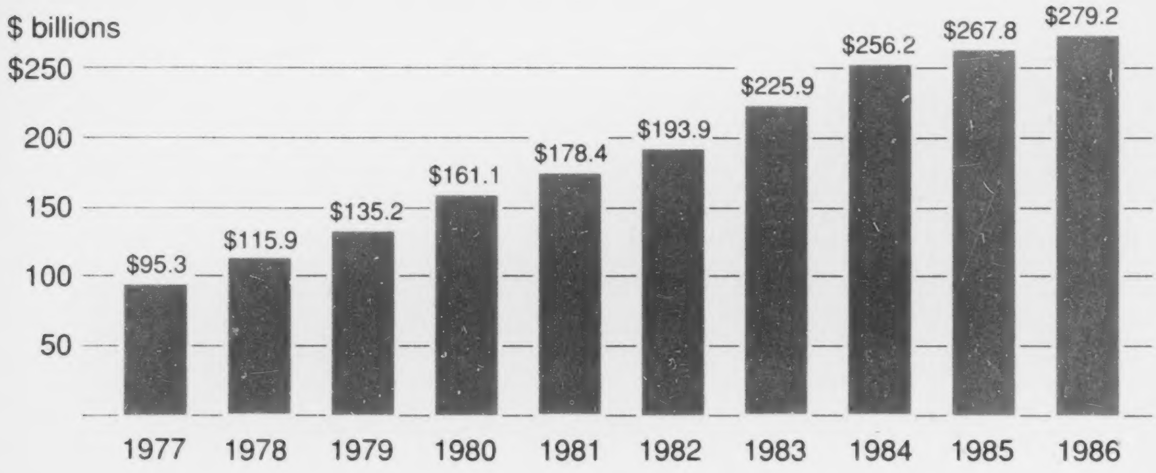
COMPOSITE PERFORMANCE

	1983	1984	Percentage change	1985	Percentage change	1986	Percentage change
Electronics sales ($ billions)	$225.9	$256.2	13.4%	$267.8	4.5%	$279.2	4.3%
Total sales ($ billions)	$732.5	$776.5	6.0%	$797.8	2.7%	$641.7	-19.6%
Net income ($ billions)	$37.4	$46.4	24.1%	$35.4	-23.7%	$26.7	-24.6%

WEIGHTED AVERAGES

	1983	1984	1985	1986
Return on equity	13.8%	16.5%	11.8%	10.2%
Return on investment	10.2%	12.6%	8.7%	7.2%
Cost of goods sold as a percentage of sales	70.0%	69.4%	70.3%	63.7%
R&D as a percentage of sales	4.1%	4.2%	4.2%	5.0%
Sales per employee	$97,300	$103,200	$110,800	$102,348
Net income per employee	$5,100	$6,300	$5,000	$4,266
Five-year compounded annual growth				
Sales	8.5%	8.5%	5.0%	8.2%
Net income	7.3%	11.6%	1.4%	4.0%
Capital outlay to net cash flow after dividends	89.8%	96.0%	118.3%	97.9%
Debt as a percentage of total capital	26.1%	23.5%	26.7%	29.9%
Foreign sales as a percentage of total sales	NA	NA	14.0%	25.4%

GROWTH OF THE TOP ELECTRONICS COMPANIES



BY JERRY WASSERMAN

The continuing tale of toil and turmoil

1986 continued the trend toward transition and change and reflected the repositioning of company strategies

The tale of toil and turmoil noted in the 1985 performance of the annual ELECTRONIC BUSINESS leading 200 companies continued through 1986. Mergers, acquisitions and divestitures all contributed to the ongoing state of flux. Industry revenue continued to grow to reach an all-time high of $279.2 billion in 1986. However, net income dropped by 25% from $35.4 billion in 1985 to $26.7 billion in 1986, indicating that companies must become more cost effective to remain competitive.

This year, 28 new companies entered the list, eight more new entrants than in 1985. The electronics revenue of the 200th company on the list increased by 6.8% from $123.6 million in 1985 to $132 million in 1986. Fourteen companies from the 1985 list disappeared due to merging, consolidation and divestiture; a key issue for the high number of new entrants. This consolidation process should continue through 1987. In addition, foreign companies will enter the U.S. market more aggressively and become significantly visible among the acquiring companies.

For the first time, ELECTRONIC BUSINESS included software companies in the top 200 list. Lotus Development Corp. entered at position number 106, with 1986 revenue of $283 million; followed by Microsoft Corp.; Reynolds & Reynolds Co.; and Ashton-Tate Corp., at position No. 141, with revenue of $211 million. Users are placing an increasing value on the software content of products in contrast to the traditional industry practice of just buying hardware.

From a performance perspective, the four software companies noted above were all robust. Their net income, return on equity, and return on investment were superior to the rest of the companies on the ELECTRONIC BUSINESS top 200 list.

The percentage of revenue invested in research and development in 1986 increased by 19%, from the 1985 value of 4.2% of total revenue to 5% of total revenue. However, we would like to stress an observation that we made years ago: Using research and development investment as an indication of performance is not necessarily valid. In the electronics industry, performance still requires that a company be cost competitive.

In 1986, the cost position looked impressive. Cost of goods sold decreased from 70.3% of total revenue in 1985 to 63.7% of total revenue in 1986. However, before we get too complacent, we must note that this positive indicator was accompanied by two negative indicators.

> A strong positive factor for the industry was an increase in foreign revenue. The 1986 total showed a hefty increase to 25.4% from the 1985 level of 14%

The net income of the ELECTRONIC BUSINESS top 200 companies dropped significantly — by 25% — from $35.4 billion in 1985 to $26.7 billion in 1986. In addition, the accumulation of debt increased to a level that is too high for the industry to maintain. Debt as a percentage of total capital rose from 26.7% in 1985 to 29.9% in 1986. This 12% increase is significant and must be adjusted in the short term. Should the high debt continue, the electronics industry will soon find itself in trouble, as many of the U.S. capital goods industries are in today.

There is also a realistic concern that the industry is being milked to show short-term profits. This is indicated in the drop in capital outlays to net cash flow after dividends, which fell from a healthy 118.3% in 1985 to a suspect 97.9% in 1986. This indicator shows how a company uses internally generated funds to support its capital expenditures on new plant and equipment. Clearly, in our increasingly competitive environment, investments in new plant and equipment are critical for a company if it is to remain competitive in this ever cost-conscious industry. Our experience has been that companies which invest between 100% and 130% of net cash flow after dividends in capital equipment are making prudent use of their funds for growth. Anything below 100% suggests that the company is being milked for profits.

A strong positive factor for the industry this year was an increase in foreign revenue. The 1986 industry total showed a hefty increase to 25.4% from the 1985 level of 14%. This is extremely important because it illustrates the clear recognition of management concerning the international character of the market and the resultant strategic thrust to expand company horizons from a domestic focus in the United States to a view of a worldwide market which must be penetrated.

Too many electronics industry chief executives are looking toward the short term in a frantic attempt to boost profits so that they can justify their existence. This indicates that 1987 may be a potentially disastrous year for a number of companies. On the other hand, the recognition of the importance of foreign sales, the increasing acceptance of software as a significant industry thrust, and the ongoing consolidation process could create a positive balance that will keep the electronics industry on an even keel in 1987, and perhaps even put it into an upward thrust for 1988 and beyond.

Overall 1986 continued the trend toward transition and change, and reflected the repositioning of company strategy and tactics that have been going on in the electronics industry for the past three years.

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REVENUE AND PROFITS

Ranking: 1 - 40

Figures in millions for the calendar year

Rank			Electronics revenue		Total company revenue		Total company profits	
1986	1985	Company	1986	1985	1986	1985	1986	1985
1	1	**IBM**	$51,250.0	$50,056.0	$51,250.0	$50,056.0	$4,789.0	$6,555.0
2	2	**AT&T**	14,979.0	17,641.9	34,087.0	34,909.5	139.0	1,556.8
3	4	**General Electric** [1]	11,300.0	7,590.0	35,211.0	28,285.0	2,492.0	2,336.0
4	3	**GM Hughes Electronics**	10,440.0	9,503.8	10,440.0	9,503.8	445.1	339.8
5	6	**DEC**	8,414.3	7,029.4	8,414.3	7,029.4	861.6	400.6
6	5	**Xerox**	8,150.0	7,545.0	9,355.0	8,732.1	488.0	380.5
7	-	**Unisys**	7,432.4	NA	7,432.4	NA	-43.4	NA
8	9	**Hewlett-Packard**	7,245.0	6,571.0	7,245.0	6,571.0	523.0	482.0
9	23	**Allied-Signal**	6,132.9	2,850.0	11,794.0	9,115.0	605.0	-279.0
10	35	**Lockheed** [2]	5,956.0	1,740.0	10,273.0	9,535.0	408.0	401.0
11	10	**Motorola**	5,888.0	5,443.0	5,888.0	5,443.0	194.0	72.0
12	8	**Honeywell**	5,378.2	6,624.6	5,378.2	6,624.6	12.9	281.6
13	13	**Texas Instruments**	4,974.0	4,924.5	4,974.0	4,924.5	39.9	-118.7
14	15	**NCR**	4,466.7	3,952.0	4,881.6	4,317.2	336.5	315.2
15	16	**Raytheon**	4,343.0	3,794.0	7,308.0	6,408.5	393.2	375.9
16	18	**Rockwell International**	4,305.0	3,590.8	12,396.9	11,741.4	634.8	580.6
17	72	**Eastman Kodak**	3,850.0	600.0	11,550.0	10,631.0	374.0	332.0
18	20	**North American Philips**	3,440.0	3,278.9	4,531.6	4,395.2	68.5	81.5
19	21	**Tandy**	3,322.8	3,137.6	3,322.8	3,137.6	225.9	203.9
20	19	**TRW**	3,170.0	3,344.5	6,035.9	5,917.2	217.7	133.7
21	17	**Control Data**	2,682.8	3,679.7	3,346.7	3,679.7	-311.1	-567.5
22	25	**Wang Laboratories**	2,668.9	2,428.3	2,668.9	2,428.3	-86.4	-63.3
23	22	**Litton Industries**	2,660.0	2,875.0	4,290.6	4,568.0	48.4	247.7
24	26	**Westinghouse Electric**	2,545.0	2,350.0	10,731.0	10,700.2	670.8	605.3
25	28	**3M**	2,460.0	2,272.0	8,602.0	7,846.0	779.0	664.0
26	29	**Ford Motor**	2,422.7	2,071.0	62,715.8	52,774.4	3,285.1	2,515.4
27	7	**ITT**	2,300.0	7,010.0	17,437.0	20,007.0	527.9	293.5
28	30	**Martin Marietta**	2,160.0	1,882.1	4,752.5	4,410.1	202.3	249.4
29	27	**Harris**	2,106.4	2,306.6	2,106.4	2,306.6	68.6	60.7
30	50	**Grumman**	2,075.0	1,128.0	3,440.1	3,098.9	78.7	81.5
31	34	**Apple Computer**	2,030.3	1,753.9	2,030.3	1,753.9	155.5	72.0
32	24	**GTE**	2,007.0	2,621.0	15,111.5	15,732.4	1,152.6	-161.1
33	32	**Boeing**	1,975.0	1,850.0	16,341.0	13,636.0	665.0	566.0
34	36	**Zenith Electronics**	1,892.1	1,623.7	1,892.1	1,623.7	-10.0	-7.7
35	33	**Eaton**	1,800.0	1,778.0	3,811.6	3,674.5	137.6	230.9
36	38	**Pitney Bowes**	1,751.9	1,603.3	1,986.7	1,831.8	166.1	144.5
37	42	**Du Pont**	1,750.0	1,400.0	27,148.0	29,483.0	1,538.0	1,118.0
38	39	**McDonnell Douglas**	1,740.0	1,575.0	12,660.6	11,665.8	277.5	345.7
39	37	**National Semiconductor**	1,678.0	1,605.8	1,678.0	1,605.8	-57.0	-89.5
40	44	**AMP**	1,595.0	1,350.0	1,933.1	1,636.1	164.3	108.0

1985 figures are as originally reported in 1985

[1] Includes RCA results from June 1, 1986

[2] Includes Sanders Associates results from July 28, 1986

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REVENUE AND PROFITS

Ranking: 41 - 80

Figures in millions for the calendar year

Rank			Electronics revenue		Total company revenue		Total company profits	
1986	1985	Company	1986	1985	1986	1985	1986	1985
41	45	Singer	$1,484.0	$1,338.0	$1,725.2	$2,416.3	$58.5	$82.3
42	31	United Technologies	1,413.0	1,877.0	15,699.2	14,991.7	48.1	636.4
43	51	Teledyne	1,375.0	1,056.8	3,241.4	3,256.2	238.3	546.4
44	41	Tektronix	1,352.4	1,419.8	1,352.4	1,419.8	55.1	70.2
45	47	Emerson Electric	1,340.0	1,213.0	5,156.2	4,679.5	414.7	402.1
46	49	Data General	1,287.5	1,199.0	1,287.5	1,199.0	7.9	2.4
47	48	Avnet	1,287.0	1,201.0	1,476.5	1,384.8	19.2	31.3
48	43	Intel	1,265.0	1,365.0	1,265.0	1,365.0	-183.3	1.6
49	53	Northrop	1,247.9	938.3	5,608.4	5,056.6	41.2	214.4
50	46	Perkin-Elmer	1,182.0	1,222.0	1,303.4	1,310.0	62.1	79.5
51	59	E-Systems	1,008.8	806.1	1,145.5	926.8	61.6	59.5
52	56	Amdahl	966.3	862.0	966.3	862.0	39.3	24.4
53	40	Gould	908.8	1,420.1	908.8	1,420.1	34.6	-100.8
54	65	Contel	900.0	681.0	3,074.0	2,556.6	232.9	239.9
55	68	General Dynamics	900.0	640.0	8,892.0	8,163.8	-62.6	373.0
56	52	Varian Associates	893.4	962.9	893.4	962.9	-8.8	15.3
57	58	General Instrument	871.7	824.7	871.7	824.7	16.2	-106.7
58	60	Prime Computer	860.2	769.7	860.2	769.7	46.9	57.8
59	61	Chrysler	860.0	744.0	22,586.3	21,255.5	1,403.6	1,640.0
60	69	Tandem Computers	835.8	634.5	835.8	634.5	79.2	32.0
61	67	Johnson Controls	833.0	657.0	2,535.2	2,105.2	83.2	88.4
62	64	Telex	817.0	683.1	817.0	683.1	72.7	67.1
63	79	Emerson Radio	770.6	502.9	770.6	502.9	28.4	10.5
64	55	General Signal	754.3	867.5	1,583.4	1,800.9	74.6	49.3
65	63	Penn Central	730.0	685.0	2,387.9	2,527.3	154.2	110.8
66	100	Seagate Technology	709.5	303.6	709.5	303.6	90.4	8.7
67	66	Storage Technology	696.0	673.4	696.0	673.4	16.8	-57.4
68	73	Loral	683.6	562.0	683.6	599.1	56.6	48.7
69	78	COMPAQ Computer	625.2	503.9	625.2	503.9	42.9	26.6
70	71	SmithKline Beckman	619.6	619.0	3,745.4	3,256.6	521.1	514.4
71	70	Advanced Micro Devices	615.2	623.8	615.2	623.8	-103.9	0.5
72	76	Intergraph	605.7	526.4	605.7	526.4	70.4	67.8
73	88	Cray Research	596.7	380.2	596.7	380.2	124.8	75.6
74	74	Corning Glass Works	580.5	534.8	1,856.3	1,690.5	162.2	133.3
75	57	M/A-COM	577.6	855.4	577.6	855.4	-21.9	32.6
76	81	Tracor	577.0	498.0	632.1	546.5	18.8	13.4
77	77	Monsanto	540.0	520.0	6,879.0	6,747.0	433.0	-98.0
78	80	Arrow Electronics	501.8	500.0	529.6	534.1	-28.3	-10.9
79	84	Computervision	494.7	441.1	494.7	441.1	-5.8	-80.8
80	75	SCI Systems	487.9	527.6	487.9	527.6	14.6	14.2

1985 figures are as originally reported in 1985

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REVENUE AND PROFITS

Ranking: 81 - 120

Figures in millions for the calendar year

Rank			Electronics revenue		Total company revenue		Total company profits	
1986	1985	Company	1986	1985	1986	1985	1986	1985
81	83	**Scientific-Atlanta**	$479.6	$443.7	$479.6	$443.7	-$7.4	$16.8
82	82	**United Telecommunications**	460.3	475.0	3,058.8	3,198.4	187.2	20.8
83	-	**Textron**	445.0	121.2	5,023.3	4,038.5	241.6	251.8
84	124	**Xidex**	419.0	225.0	533.5	342.1	32.6	25.6
85	87	**Medtronic**	397.0	387.6	469.2	387.6	69.8	49.3
86	101	**Apollo Computer**	391.7	295.6	391.7	295.6	9.3	-1.5
87	90	**Ducommun**	386.6	347.5	455.2	419.6	-19.2	-3.3
88	95	**Tyler**	384.3	325.3	961.4	912.4	11.9	15.4
89	122	**Western Digital**	352.8	227.6	352.8	227.6	32.4	-2.9
90	89	**Dataproducts**	350.8	370.6	350.8	370.6	14.6	-29.7
91	110	**Molex**	349.4	255.4	349.4	255.4	38.9	28.2
92	85	**Compugraphic**	341.1	400.8	341.1	400.8	3.4	21.8
93	-	**Sun Microsystems**	341.1	NA	341.1	NA	24.5	NA
94	94	**Diebold**	340.0	329.0	413.7	410.9	34.9	30.4
95	97	**Analog Devices**	336.1	319.7	336.1	319.7	20.2	26.4
96	91	**EG&G**	325.0	337.0	1,145.1	1,177.1	44.9	55.7
97	99	**Cubic**	318.0	305.0	344.9	341.7	2.5	12.2
98	93	**Datapoint**	317.3	331.3	317.3	331.3	-67.3	-68.7
99	143	**AM International**	317.0	186.0	959.7	614.0	0.7	23.3
100	92	**Teradyne**	306.1	336.4	306.1	336.4	0.2	20.2
101	86	**Convergent Technologies**	305.8	395.2	305.8	395.2	-32.8	11.5
102	102	**DSC Communications**	304.0	287.6	304.0	287.6	11.0	-63.3
103	96	**TIE/communications**	298.2	321.3	298.2	321.3	-59.3	-77.9
104	103	**Foxboro**	293.8	286.0	544.0	572.2	7.1	-34.2
105	116	**Dynatech**	288.9	238.1	288.9	238.1	23.8	22.0
106	-	**Lotus Development**	282.9	225.5	282.9	225.5	48.3	38.1
107	106	**Kollmorgen**	278.0	277.0	319.2	311.0	-19.9	-6.4
108	98	**Savin**	272.0	310.0	362.7	431.7	-11.1	-102.7
109	120	**Marshall Industries**	269.2	231.6	269.2	231.6	4.5	1.5
110	108	**Premier Industrial**	268.0	269.0	442.5	433.7	41.7	39.3
111	107	**Dover**	263.5	276.0	1,439.8	1,439.5	83.8	100.0
112	112	**Paradyne**	261.1	252.5	261.1	252.5	-38.5	-31.2
113	111	**Augat**	260.4	255.0	260.4	255.0	-8.7	12.1
114	-	**Microsoft**	260.2	NA	260.2	NA	57.7	NA
115	-	**Atari**	258.1	NA	258.1	NA	25.1	NA
116	131	**LTV**	257.0	214.0	7,271.4	8,198.8	-3,251.6	-723.9
117	117	**Bally Manufacturing**	256.0	238.0	1,592.8	1,344.8	23.7	25.6
118	119	**Watkins-Johnson**	255.4	232.6	255.4	232.6	17.2	18.4
119	105	**Emhart**	255.0	284.0	2,094.3	1,775.4	-10.2	80.5
120	145	**Nashua**	254.0	185.0	704.2	621.6	20.6	16.4

1985 figures are as originally reported in 1985

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REVENUE AND PROFITS

Ranking: 121 - 160

Figures in millions for the calendar year

Rank			Electronics revenue		Total company revenue		Total company profits	
1986	1985	Company	1986	1985	1986	1985	1986	1985
121	114	Square D	$252.6	$246.0	$1,403.5	$1,348.1	$98.9	$87.2
122	115	Union Carbide	248.0	240.0	6,343.0	9,003.0	130.0	-581.0
123	125	Eli Lilly	247.0	222.2	3,702.4	3,270.6	558.2	517.6
124	147	Recognition Equipment	246.6	179.4	246.6	179.4	9.7	3.6
125	109	CTS	245.5	261.6	245.5	261.6	-26.6	9.4
126	160	Polaroid	244.0	160.0	1,629.2	1,295.2	103.5	36.9
127	123	Tandon	242.8	225.9	242.8	225.9	-62.6	-119.1
128	136	Cincinnati Milacron	242.0	206.0	850.0	732.2	23.3	-44.8
129	132	Figgie International	240.8	208.0	919.8	803.4	42.4	29.2
130	-	BRIntec	232.0	NA	310.7	NA	11.8	NA
131	-	Wyse Technology	228.4	NA	228.4	NA	16.7	NA
132	-	Reynolds & Reynolds	227.0	NA	452.5	NA	23.4	NA
133	126	Cooper Industries	226.0	220.0	3,433.3	3,067.2	147.7	135.1
134	138	Wyle Laboratories	224.6	195.4	307.0	260.8	4.3	1.5
135	150	Sundstrand	220.0	177.0	1,433.9	1,284.1	45.4	74.4
136	164	Diasonics	217.1	157.9	217.1	157.9	5.9	7.3
137	135	Pioneer-Standard	214.2	207.2	214.2	207.2	-0.4	0.2
138	-	Micropolis	213.1	94.9	213.1	94.9	18.3	2.8
139	134	Gerber Scientific	213.0	207.3	213.0	207.3	19.7	19.7
140	154	Monolithic Memories	213.0	171.6	213.0	171.6	9.9	5.5
141	-	Ashton-Tate	210.8	NA	210.8	NA	30.1	NA
142	137	Spectra-Physics	208.8	198.9	208.8	198.9	0.9	-1.7
143	130	Fluke	208.5	214.7	208.5	214.7	11.6	14.5
144	140	Avantek	208.2	190.3	208.2	190.3	16.1	17.7
145	142	Logicon	204.5	187.9	204.5	187.9	9.3	9.6
146	127	GenRad	204.3	218.3	204.3	218.3	-29.9	-52.3
147	133	Andrew	198.0	207.8	198.0	207.8	9.5	12.2
148	-	Bolt Beranek and Newman	196.6	96.4	196.6	160.6	12.9	9.6
149	148	AVX	195.4	178.7	195.4	178.7	-3.1	-12.3
150	152	Decision Industries	195.1	176.4	195.1	176.4	7.8	7.8
151	176	LSI Logic	194.3	140.0	194.3	140.0	3.9	10.1
152	151	Measurex	192.7	176.6	192.7	176.6	21.1	17.7
153	144	Bell Industries	192.0	185.0	319.1	295.8	3.2	4.5
154	139	Micom Systems	191.6	194.2	191.6	194.2	9.5	14.9
155	128	Bell & Howell	190.0	217.0	853.4	759.8	32.9	32.2
156	146	General DataComm	189.2	179.4	189.2	179.4	3.9	8.7
157	141	Ball	187.5	188.5	1,070.3	1,106.2	58.9	51.2
158	-	MiniScribe	184.9	114.0	184.9	114.0	20.3	-16.8
159	121	NBI	181.0	230.0	283.1	260.7	-10.4	7.8
160	167	Cipher Data Products	180.8	152.5	180.8	152.5	7.5	7.9

1985 figures are as originally reported in 1985

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REVENUE AND PROFITS

Ranking: 161 - 200

Figures in millions for the calendar year

Rank			Electronics revenue		Total company revenue		Total company profits	
1986	1985	Company	1986	1985	1986	1985	1986	1985
161	187	**Electrospace Systems**	$179.9	$133.2	$179.9	$133.2	$10.0	$12.6
162	166	**Kidde**	175.0	155.0	2,356.2	2,164.8	52.2	72.2
163	162	**ADT**	174.3	158.0	519.2	479.6	22.3	-56.6
164	180	**Mentor Graphics**	173.5	136.7	173.5	136.7	11.0	8.0
165	161	**Allen Group**	173.0	159.0	423.2	399.2	-8.6	16.7
166	170	**Veeco Instruments**	170.7	150.4	170.7	150.4	0.5	7.3
167	-	**Ametek**	170.0	106.7	568.5	502.8	36.6	34.9
168	155	**AST Research**	168.9	171.0	168.9	171.0	17.3	29.2
169	179	**Sun Electric**	167.0	139.0	186.0	168.8	2.5	-7.8
170	189	**Analogic**	166.5	132.4	166.5	132.4	17.3	10.3
171	163	**Tyco Laboratories**	166.0	158.0	1,037.6	646.2	42.6	31.1
172	-	**Ultimate**	163.0	NA	163.0	NA	13.9	NA
173	158	**ISC Systems**	162.4	161.5	162.4	161.5	10.8	11.5
174	-	**Genicom**	157.5	NA	157.5	NA	8.6	NA
175	-	**Data Card**	157.0	123.2	182.5	136.9	2.1	10.4
176	-	**Digital Communications**	156.9	114.1	156.9	114.1	22.9	14.7
177	174	**International Rectifier**	151.7	142.0	151.7	141.1	0.2	-0.8
178	159	**Applied Materials**	151.5	160.1	151.5	160.1	-0.5	5.9
179	173	**Esterline**	151.0	142.0	233.6	246.1	0.6	0.0
180	-	**Mark IV Industries**	151.0	NA	244.8	NA	9.1	NA
181	169	**Becton, Dickinson & Co.**	150.0	151.0	1,389.7	1,156.1	124.8	92.4
182	157	**Unitrode**	149.4	168.0	149.4	168.0	-7.0	9.2
183	193	**Dynascan**	146.8	128.1	146.8	128.1	6.1	0.1
184	-	**Maxtor**	147.9	NA	147.9	NA	22.2	NA
185	175	**Mark Controls**	145.0	140.8	262.7	279.0	1.5	2.7
186	-	**ADC Telecommunications**	144.9	NA	144.9	NA	11.4	NA
187	-	**Intelligent Systems**	143.5	122.7	143.5	122.7	1.8	-8.3
188	-	**UCCEL**	141.6	NA	141.6	NA	17.2	NA
189	195	**Burndy**	140.0	127.0	242.1	219.0	9.5	-9.1
190	153	**Pittway**	140.0	175.0	585.7	548.5	27.6	31.1
191	-	**Sun Chemical**	140.0	97.0	371.4	326.6	26.1	1.3
192	190	**Altos Computer Systems**	139.5	132.2	139.5	132.2	19.1	9.9
193	181	**Coherent**	138.4	136.6	138.4	136.6	-0.2	5.9
194	-	**Applied Magnetics**	137.0	120.4	137.0	120.4	4.4	4.0
195	185	**United Industrial**	137.0	135.0	272.5	269.4	-9.2	19.1
196	188	**Aydin**	136.8	133.0	136.8	133.0	7.0	3.8
197	177	**Fairchild Industries**	134.0	140.0	643.3	855.9	7.6	-167.1
198	-	**Anthem Electronics**	132.7	103.6	132.7	103.6	2.8	3.2
199	-	**Olin**	132.0	NA	1,707.3	NA	75.2	NA
200	-	**Thomas & Betts**	132.0	95.4	347.4	318.0	38.0	33.4

1985 figures are as originally reported in 1985

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ALPHABETICAL INDEX

Company	Rank
ADC Telecommunications Inc.	186
ADT Inc.	163
Advanced Micro Devices Inc.	71
Allen Group Inc., The	165
Allied-Signal Inc.	9
Altos Computer Systems	192
Amdahl Corp.	52
Ametek Inc.	167
AM International Inc.	99
AMP Inc.	40
Analog Devices Inc.	95
Analogic Corp.	170
Andrew Corp.	147
Anthem Electronics Inc.	198
Apollo Computer Inc.	86
Apple Computer Inc.	31
Applied Magnetics Corp.	194
Applied Materials Inc.	178
Arrow Electronics Inc.	78
Ashton-Tate Corp.	141
AST Research Inc.	168
Atari Corp.	115
AT&T	2
Augat Inc.	113
Avantek Inc.	144
Avnet Inc.	47
AVX Corp.	149
Aydin Corp.	196
Ball Corp.	157
Bally Manufacturing Corp.	117
Becton, Dickinson & Co.	181
Bell & Howell Co.	155
Bell Industries Inc.	153
Boeing Co., The	33
Bolt Beranek and Newman Inc.	148
BRIntec Corp.	130
Burndy Corp.	189
Chrysler Corp.	59
Cincinnati Milacron Inc.	128
Cipher Data Products Inc.	160
Coherent Inc.	193
COMPAQ Computer Corp.	69
Compugraphic Corp.	92
Computervision Corp.	79
Contel Corp.	54
Control Data Corp.	21
Convergent Technologies Inc.	101
Cooper Industries Inc.	133
Corning Glass Works	74
Cray Research Inc.	73
CTS Corp.	125
Cubic Corp.	97
Data Card Corp.	175
Data General Corp.	46
Datapoint Corp.	98
Dataproducts Corp.	90
Decision Industries Corp.	150
Diasonics Inc.	136
Diebold Inc.	94
Digital Communications Associates	176
Digital Equipment Corp.	5
DSC Communications Corp.	102
Dover Corp.	111
Ducommun Inc.	87
Du Pont de Nemours and Co., E.I.	37
Dynascan Corp.	183
Dynatech Corp.	105
Eastman Kodak Co.	17
Eaton Corp.	35
EG&G Inc.	96
Electrospace Systems Inc.	161
Eli Lilly & Co.	123
Emerson Electric Co.	45
Emerson Radio Corp.	63
Emhart Corp.	119
Esterline Corp.	179
E-Systems Inc.	51
Fairchild Industries Inc.	197
Figgie International Inc.	129
Fluke Manufacturing Co. Inc., John	143
Ford Motor Co.	26
Foxboro Co., The	104
General DataComm Industries Inc.	156
General Dynamics Corp.	55
General Electric Co.	3
General Instrument Corp.	57
General Signal Corp.	64
Genicom Corp.	174
GenRad Inc.	146
Gerber Scientific Inc.	139
GM Hughes Electronics Corp.	4
Gould Inc.	53
Grumman Corp.	30
GTE Corp.	32
Harris Corp.	29
Hewlett-Packard Co.	8
Honeywell Inc.	12
IBM Corp.	1
Intel Corp.	48
Intelligent Systems Corp.	187
Intergraph Corp.	72
International Rectifier Corp.	177
ISC Systems Corp.	173
ITT Corp.	27
Johnson Controls Inc.	61
Kidde Inc.	162
Kollmorgen Corp.	107
Litton Industries Inc.	23
Lockheed Corp.	10
Logicon Inc.	145
Loral Corp.	68
Lotus Development Corp.	106
LSI Logic Corp.	151
LTV Corp.	116
M/A-COM Inc.	75
Mark Controls	185
Mark IV Industries Inc.	180
Marshall Industries	109
Martin Marietta Corp.	28
Maxtor Corp.	184
McDonnell Douglas Corp.	38
Measurex Corp.	152
Medtronic Inc.	85
Mentor Graphics Corp.	164
Micom Systems Inc.	154
Micropolis Corp.	138
Microsoft Corp.	114
MiniScribe Corp.	158
Minnesota Mining & Manufacturing Co.	25
Molex Inc.	91
Monolithic Memories Inc.	140
Monsanto Co.	77
Motorola Inc.	11
Nashua Corp.	120
National Semiconductor Corp.	39
NBI Inc.	159
NCR Corp.	14
North American Philips Corp.	18
Northrop Corp.	49
Olin Corp.	199
Paradyne Corp.	112
Penn Central Corp.	65
Perkin-Elmer Corp., The	50
Pioneer-Standard Electronics Inc.	137
Pitney Bowes Inc.	36
Pittway Corp.	190
Polaroid Corp.	126
Premier Industrial Corp.	110
Prime Computer Inc.	58
Raytheon Co.	15
Recognition Equipment Inc.	124
Reynolds & Reynolds Co.	132
Rockwell International Corp.	16
Savin Corp.	108
Scientific-Atlanta Inc.	81
SCI Systems Inc.	80
Seagate Technology	66
Singer Co., The	41
SmithKline Beckman Corp.	70
Spectra-Physics Inc.	142
Square D	121
Storage Technology Corp.	67
Sun Chemical Corp.	191
Sundstrand Corp.	135
Sun Electric Corp.	169
Sun Microsystems Inc.	93
Tandem Computers Inc.	60
Tandon Corp.	127
Tandy Corp.	19
Tektronix Inc.	44
Teledyne Inc.	43
Telex Corp., The	62
Teradyne Inc.	100
Texas Instruments Inc.	13
Textron Inc.	83
Thomas & Betts Corp.	200
TIE/communications Inc.	103
Tracor Inc.	76
TRW Inc.	20
Tyco Laboratories Inc.	171
Tyler Corp.	88
UCCEL Corp.	188
Ultimate Corp., The	172
Union Carbide Inc.	122
Unisys Corp.	7
United Industrial Corp.	195
United Technologies Corp.	42
United Telecommunications Inc.	82
Unitrode Corp.	182
Varian Associates Inc.	56
Veeco Instruments Inc.	166
Wang Laboratories Inc.	22
Watkins-Johnson Co.	118
Western Digital Corp.	89
Westinghouse Electric Corp.	24
Wyle Laboratories Inc.	134
Wyse Technology	131
Xerox Corp.	6
Xidex Corp.	84
Zenith Electronics Corp.	34

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INDUSTRY SEGMENTS

Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	Rank
SEMICONDUCTORS								
Western Digital	$113.2	7.7%	13.0%	58.7%	8.8%	5.8%	33.0%	89
LSI Logic	106.7	2.0%	1.1%	50.4%	11.1%	36.3%	21.2%	151
Gould	85.6	3.8%	3.6%	47.8%	10.8%	6.3%	19.3%	53
Intel	69.5	-14.5%	-10.9%	50.3%	18.0%	12.2%	39.9%	48
Analog Devices	67.4	7.0%	7.6%	36.8%	13.5%	11.0%	47.3%	95
Texas Instruments	64.4	0.8%	2.0%	72.6%	8.2%	9.0%	25.8%	13
International Rectifier	63.1	-1.2%	-1.1%	66.2%	6.4%	6.2%	46.4%	177
Motorola	62.4	3.3%	5.7%	54.1%	8.4%	10.1%	38.2%	11
Unitrode	55.2	-4.7%	-5.2%	58.3%	8.2%	6.5%	20.0%	182
Monolithic Memories	48.8	4.3%	3.8%	44.9%	17.2%	16.2%	26.2%	140
National Semiconductor	48.0	-10.0%	-17.5%	63.5%	15.0%	7.9%	37.9%	39
Advanced Micro Devices	43.0	-6.4%	-8.6%	40.8%	31.9%	23.8%	23.9%	71
General Instrument	38.7	-8.4%	-11.3%	76.7%	5.2%	9.2%	19.0%	57
Weighted average	**$60.6**	**-0.7%**	**-1.0%**	**60.0%**	**10.6%**	**10.2%**	**32.0%**	
COMPONENTS (Other than semiconductors)								
CTS	$127.6	-10.8%	-16.0%	77.2%	0.0%	11.0%	17.2%	125
AMP	88.7	8.5%	12.4%	59.2%	8.8%	7.8%	40.1%	40
Kollmorgen	77.8	-6.2%	-13.8%	72.9%	5.2%	3.9%	7.7%	107
BRIntec	70.6	3.8%	8.6%	72.7%	1.9%	2.6%	12.4%	130
Augat	70.3	-3.4%	-3.6%	70.1%	6.4%	9.2%	18.5%	113
Molex	66.3	11.0%	12.0%	45.3%	5.9%	13.7%	63.5%	91
AVX	38.3	-1.6%	-1.5%	72.3%	2.8%	5.7%	34.7%	149
Weighted average	**$78.3**	**4.2%**	**6.0%**	**63.2%**	**6.5%**	**7.7%**	**33.2%**	
PERIPHERALS								
AST Research	$215.4	15.8%	31.0%	42.5%	4.9%	3.7%	27.8%	168
Intelligent Systems	194.6	0.0%	0.1%	62.7%	4.6%	3.2%	20.1%	187
Decision Industries	121.9	4.0%	7.8%	61.9%	5.2%	3.6%	27.0%	150
Micropolis	118.9	8.6%	16.5%	71.8%	5.2%	7.6%	17.7%	138
Wyse Technology	118.6	7.6%	15.5%	64.8%	5.4%	5.3%	13.5%	131
Maxtor	87.1	12.5%	21.1%	65.8%	7.0%	9.1%	25.2%	184
Dataproducts	84.2	-7.6%	-9.8%	70.0%	8.8%	2.6%	23.3%	90
Storage Technology	80.9	2.4%	NA	59.7%	8.9%	4.6%	20.3%	67
Tandon	75.1	-29.3%	-101.4%	86.3%	7.9%	3.8%	69.4%	127
Xidex	66.5	7.5%	5.5%	65.1%	2.5%	12.1%	24.7%	84
Cipher Data Products	65.6	4.4%	5.4%	63.4%	9.2%	3.9%	30.9%	160
MiniScribe	63.8	11.0%	22.3%	71.1%	4.6%	11.4%	22.0%	158
Genicom	63.0	5.5%	12.9%	61.6%	3.9%	2.9%	20.1%	174
Seagate Technology	51.7	7.5%	15.4%	76.2%	4.1%	8.4%	36.7%	66
Applied Magnetics	31.5	3.2%	4.0%	65.4%	13.2%	8.1%	33.9%	194
Weighted average	**$86.3**	**2.1%**	**3.9%**	**65.1%**	**6.5%**	**6.0%**	**25.9%**	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

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INDUSTRY SEGMENTS

Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	Rank
MAINFRAMES								
Cray Research	$149.2	20.9%	21.7%	24.5%	14.7%	20.0%	53.8%	73
Amdahl	134.2	4.1%	5.7%	50.7%	12.3%	11.8%	43.5%	52
IBM	127.0	9.3%	12.0%	37.8%	7.8%	9.0%	50.5%	1
Control Data	97.3	-9.3%	-20.0%	61.7%	9.4%	4.7%	32.5%	21
NCR	78.7	6.9%	13.0%	47.3%	6.6%	7.4%	43.8%	14
Unisys	77.4	-0.6%	-0.7%	62.9%	5.9%	7.4%	42.9%	7
Weighted average	**$112.8**	**7.2%**	**9.5%**	**42.5%**	**7.7%**	**8.7%**	**48.3%**	
MINICOMPUTERS								
Tandem Computers	$134.3	8.3%	11.7%	26.7%	11.3%	8.5%	39.6%	60
IBM	127.0	9.3%	12.0%	37.8%	7.8%	9.0%	50.5%	1
Convergent Technologies	124.2	-10.7%	-13.7%	68.3%	10.7%	11.3%	14.0%	101
Apollo Computer	109.5	2.4%	3.0%	46.4%	11.4%	10.6%	47.8%	86
Sun Microsystems	103.4	5.7%	9.4%	45.9%	14.6%	17.2%	20.5%	93
Prime Computer	99.8	5.5%	10.3%	40.1%	10.7%	10.5%	47.2%	58
Telex	94.1	9.7%	16.4%	51.0%	5.5%	14.6%	15.6%	62
Hewlett-Packard	86.6	7.3%	10.9%	42.7%	11.6%	7.0%	46.3%	8
Gould	85.6	3.8%	3.6%	47.8%	10.8%	6.3%	19.3%	53
Data General	81.5	-2.3%	-3.0%	50.9%	11.3%	10.2%	36.4%	46
DEC	80.2	8.1%	10.1%	51.4%	10.7%	7.4%	41.9%	5
Analogic	80.1	6.8%	5.9%	51.3%	12.4%	5.1%	42.4%	170
Weighted average	**$112.1**	**8.5%**	**11.1%**	**40.4%**	**8.7%**	**8.7%**	**47.8%**	
MICROCOMPUTERS								
Apple Computer	$339.6	2.1%	5.7%	44.2%	6.7%	3.5%	25.8%	31
COMPAQ Computer	284.2	6.9%	16.7%	55.3%	4.3%	8.1%	19.1%	69
Altos Computer Systems	186.9	15.1%	18.7%	57.9%	8.0%	1.9%	35.0%	192
Atari	184.4	9.7%	23.3%	57.3%	5.6%	0.3%	53.2%	115
IBM	127.0	9.3%	12.0%	37.8%	7.8%	9.0%	50.5%	1
SCI Systems	90.7	2.9%	7.0%	92.6%	0.0%	2.3%	21.1%	80
Tandy	84.3	6.5%	11.8%	44.9%	0.0%	1.8%	2.6%	19
Weighted average	**$126.9**	**8.9%**	**11.9%**	**39.2%**	**7.2%**	**8.3%**	**46.6%**	
COMPUTER-BASED SYSTEMS								
Intergraph	$106.3	11.6%	13.7%	46.1%	9.5%	12.9%	34.2%	72
Coherent	99.3	-0.6%	-0.8%	61.6%	10.7%	6.4%	42.7%	193
ISC Systems	90.2	8.3%	12.0%	49.5%	9.0%	4.1%	0.0%	173
Hewlett-Packard	86.6	7.3%	10.9%	42.7%	11.6%	7.0%	46.3%	8
Compugraphic	85.4	1.0%	1.5%	49.6%	11.3%	4.3%	24.8%	92
Recognition Equipment	82.0	4.4%	6.0%	56.4%	4.8%	5.0%	46.0%	124
Data Card	79.5	6.9%	12.5%	54.3%	5.8%	7.2%	28.8%	175
Measurex	77.4	10.9%	13.3%	51.3%	7.3%	3.8%	51.0%	152
Sun Electric	70.6	1.1%	3.4%	53.3%	3.2%	1.9%	31.5%	169
Honeywell	68.9	0.2%	0.4%	67.4%	4.6%	5.2%	21.7%	12
Weighted average	**$79.3**	**4.6%**	**6.7%**	**53.0%**	**8.5%**	**6.4%**	**35.3%**	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

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INDUSTRY SEGMENTS

Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	Rank
COMMUNICATIONS								
Dynascan	$215.9	4.1%	8.2%	71.5%	1.6%	1.2%	5.1%	183
TIE/communications	175.4	-19.9%	-25.5%	73.9%	7.7%	0.8%	25.7%	103
Digital Communications	156.1	14.9%	17.3%	30.7%	11.3%	6.0%	17.3%	176
Scientific-Atlanta	134.0	-2.0%	-4.3%	71.3%	5.9%	3.7%	16.0%	81
DSC Communications	128.5	3.6%	3.3%	51.8%	15.2%	6.3%	0.0%	102
Dynatech	100.7	8.0%	17.7%	40.9%	8.6%	4.8%	22.9%	105
Micom Systems	93.3	5.7%	6.4%	44.8%	8.4%	4.4%	27.7%	154
Andrew	84.8	4.8%	5.7%	62.0%	6.7%	5.2%	32.3%	147
Bolt Beranek and Newman	84.3	6.4%	13.4%	55.9%	4.8%	9.7%	0.0%	148
ADC Telecommunications	83.1	8.3%	18.7%	46.6%	9.0%	7.0%	10.4%	186
Paradyne	75.5	-14.7%	-0.5%	60.7%	7.4%	7.9%	11.0%	112
General DataComm	70.7	2.2%	2.6%	55.9%	11.0%	9.0%	23.2%	156
Aydin	68.4	5.1%	10.7%	62.8%	5.5%	1.9%	28.1%	196
Avantek	67.0	7.7%	10.9%	50.5%	12.2%	9.7%	14.0%	144
M/A-COM	64.0	1.5%	1.4%	63.0%	5.9%	17.0%	10.2%	75
Motorola	62.4	3.3%	5.7%	54.1%	8.4%	10.1%	38.2%	11
General Instrument	38.7	-8.4%	-11.3%	76.7%	5.2%	9.2%	19.0%	57
Weighted average	**$66.9**	**1.5%**	**1.1%**	**57.4%**	**8.0%**	**9.0%**	**28.7%**	
GOVERNMENT								
GM Hughes Electronics	$102.4	4.3%	6.1%	74.1%	3.9%	8.3%	12.2%	4
Harris	83.0	2.7%	5.4%	61.1%	5.3%	5.3%	6.9%	29
Watkins-Johnson	81.1	6.8%	13.3%	59.3%	6.4%	5.3%	14.2%	118
Loral	81.0	8.0%	12.0%	81.5%	4.7%	7.0%	0.0%	68
Logicon	80.8	5.0%	19.1%	83.2%	0.5%	1.8%	0.0%	145
E-Systems	76.4	5.4%	13.8%	80.5%	0.0%	4.2%	6.9%	51
Cubic	75.1	0.3%	0.7%	77.9%	1.7%	2.6%	0.0%	97
Electrospace Systems	71.1	9.2%	22.7%	81.4%	2.4%	9.3%	0.0%	161
Honeywell	68.9	0.2%	0.4%	67.4%	4.6%	5.2%	21.7%	12
Texas Instruments	64.4	0.8%	2.0%	72.6%	8.2%	9.0%	25.8%	13
Singer	62.6	3.3%	6.2%	79.7%	2.4%	5.2%	0.0%	41
Motorola	62.4	3.3%	5.7%	54.1%	8.4%	10.1%	38.2%	11
Tracor	60.2	3.0%	5.1%	72.8%	2.4%	5.7%	8.8%	76
Weighted average	**$75.2**	**2.9%**	**4.9%**	**69.1%**	**5.2%**	**7.5%**	**18.5%**	
DISTRIBUTORS								
Anthem Electronics	$394.5	3.0%	7.5%	77.0%	0.0%	0.7%	0.0%	198
Arrow Electronics	249.2	-5.3%	-17.9%	77.5%	0.0%	0.4%	0.0%	78
Marshall Industries	226.0	1.2%	2.9%	75.1%	0.0%	4.4%	0.0%	109
Pioneer-Standard	215.8	-1.0%	-2.4%	76.5%	0.0%	0.9%	0.0%	137
Ducommun	189.7	-4.2%	-9.3%	78.4%	0.0%	2.6%	0.0%	87
Wyle Laboratories	163.9	1.4%	4.8%	75.7%	0.0%	2.6%	0.0%	134
Avnet	153.0	1.7%	3.1%	73.5%	0.0%	1.6%	0.0%	47
Weighted average	**$181.7**	**-0.5%**	**-1.1%**	**75.5%**	**0.0%**	**1.8%**	**0.0%**	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

INDUSTRY SEGMENTS

Company	Revenue per employee ($ thousands)	Profit as a percentage of revenue	Return on investment	Cost of goods sold as a percentage of revenue	R&D as a percentage of revenue	Capital expenditures as a percentage of revenue	Foreign revenue as a percentage of revenue	Rank
OFFICE EQUIPMENT								
Savin	$138.3	-3.1%	-10.2%	55.5%	1.7%	3.7%	0.0%	108
IBM	127.0	9.3%	12.0%	37.8%	7.8%	9.0%	50.5%	1
Xerox	93.2	5.2%	6.8%	42.8%	6.9%	11.0%	40.4%	6
Datapoint	89.8	-4.7%	-4.5%	42.6%	7.0%	8.1%	69.6%	98
Wang Laboratories	83.5	1.9%	2.3%	46.9%	7.7%	8.8%	39.7%	22
Harris	83.0	2.7%	5.4%	61.1%	5.3%	5.3%	6.9%	29
NCR	78.7	6.9%	13.0%	47.3%	6.6%	7.4%	43.8%	14
Diebold	77.8	8.4%	10.6%	62.5%	3.0%	3.6%	5.0%	94
Pitney Bowes	68.1	8.4%	14.3%	30.9%	2.7%	10.5%	17.3%	36
Weighted average	**$110.4**	**8.0%**	**10.7%**	**40.2%**	**7.3%**	**9.0%**	**45.7%**	
SOFTWARE								
Ultimate	$310.9	10.3%	20.5%	50.2%	0.0%	4.0%	16.9%	172
Lotus Development	199.1	17.1%	32.8%	14.3%	11.5%	5.5%	42.6%	106
Ashton-Tate	191.6	14.3%	22.9%	12.7%	9.2%	4.3%	28.2%	141
Mentor Graphics	190.9	6.3%	6.2%	50.7%	9.7%	5.9%	44.0%	164
Microsoft	171.3	19.9%	28.2%	17.8%	10.4%	7.1%	24.0%	114
UCCEL	107.3	12.2%	8.4%	19.6%	9.0%	8.3%	20.6%	188
Weighted average	**$180.4**	**14.0%**	**18.4%**	**25.1%**	**8.9%**	**5.8%**	**31.1%**	
CAPITAL EQUIPMENT								
Gerber Scientific	$112.8	9.5%	10.4%	44.3%	9.3%	3.7%	33.4%	139
Applied Materials	105.5	0.8%	1.0%	54.4%	16.5%	7.7%	53.5%	178
Computervision	103.6	-1.2%	-1.7%	46.9%	9.4%	5.0%	29.7%	79
GenRad	91.2	-14.6%	-16.7%	46.1%	17.6%	5.6%	42.4%	146
Perkin-Elmer	88.5	5.6%	7.5%	52.5%	8.1%	5.3%	39.1%	50
Hewlett-Packard	86.6	7.3%	10.9%	42.7%	11.6%	7.0%	46.3%	8
Fluke	83.6	5.8%	8.5%	41.3%	11.5%	4.3%	38.1%	143
Spectra-Physics	83.1	0.4%	0.5%	56.8%	8.5%	7.7%	48.1%	142
Tektronix	78.2	2.9%	4.2%	42.7%	14.6%	5.0%	38.8%	44
Varian Associates	76.8	-1.7%	-3.0%	68.6%	9.2%	5.6%	22.8%	56
Teradyne	71.2	0.1%	0.1%	48.9%	16.6%	9.9%	34.0%	100
Weighted average	**$85.6**	**4.9%**	**7.2%**	**46.3%**	**11.5%**	**6.4%**	**41.8%**	

For purposes of comparison, only companies whose electronics revenue constitutes over 70% of total revenue are included

BEST AND WORST PERFORMERS

Five-year revenue growth

(Percentage change per year)

TOP 10	
AST Research	375.3%
MiniScribe	369.6%
Apollo Computer	158.4%
Ashton-Tate	125.1%
Seagate Technology	115.9%
Convergent Technologies	87.8%
Digital Communications	69.8%
Western Digital	63.5%
Du Pont	58.6%
Ultimate	55.4%

BOTTOM 5	
Singer	-8.3%
Union Carbide	-9.0%
Sun Chemical	-9.1%
Fairchild Industries	-12.6%
ITT	-15.2%

Revenue per employee

($ thousands)

TOP 10	
Emerson Radio	$821.9
Anthem Electronics	$394.5
Apple Computer	$339.6
Ultimate	$310.9
COMPAQ Computer	$284.2
Arrow Electronics	$249.2
Marshall Industries	$226.0
Dynascan	$215.9
Pioneer-Standard Electronics	$215.8
AST Research	$215.4

BOTTOM 5	
Advanced Micro Devices	$43.0
General Instrument	$38.7
AVX	$38.3
Applied Magnetics	$31.5
Sun Chemical	$23.7

Return on investment

(Percentage)

TOP 10	
Lotus Development	32.8%
SmithKline Beckman	31.8%
AST Research	31.0%
Microsoft	28.2%
Atari	23.3%
Ashton-Tate	22.9%
Electrospace Systems	22.7%
MiniScribe	22.3%
Cray Research	21.7%
Maxtor	21.1%

BOTTOM 5	
Arrow Electronics	-17.9%
Diasonics	-18.8%
Control Data	-20.0%
TIE/communications	-25.5%
Tandon	-101.4%

Five-year net income growth

(Percentage change per year)

TOP 10	
AST Research	377.0%
Digital Communications	207.4%
Micropolis	136.4%
Seagate Technology	82.9%
Ultimate	71.8%
Bolt Beranek and Newman	64.5%
Measurex	58.6%
Altos Computer Systems	53.5%
Intergraph	53.5%
Telex	52.9%

BOTTOM 5	
Teradyne	-44.5%
Honeywell	-45.0%
Esterline	-45.3%
Veeco Instruments	-48.2%
Intelligent Systems	-53.9%

Net income per employee

($ thousands)

TOP 10	
AST Research	$34.0
Lotus Development	$34.0
Microsoft	$34.0
Ultimate	$32.1
Cray Research	$31.2
Altos Computer Systems	$28.2
Ashton-Tate	$27.4
Digital Communications	$23.3
COMPAQ Computer	$19.5
Eli Lilly	$19.2

BOTTOM 5	
GenRad	-$13.3
CTS	-$13.8
Tandon	-$22.0
TIE/communications	-$34.9
LTV	-$67.3

Return on equity

(Percentage)

TOP 10	
Lotus Development	42.1%
SmithKline Beckman	40.2%
AST Research	31.4%
MiniScribe	30.6%
Ultimate	30.0%
Cray Research	28.2%
Microsoft	28.2%
Sun Electric	27.5%
Chrysler	26.3%
Electrospace Systems	26.0%

BOTTOM 5	
GenRad	-28.3%
Control Data	-31.0%
Ducommun	-36.2%
TIE/communications	-37.9%
Tandon	-122.7%

R&D

(Percentage of total revenue)

TOP 10	
Advanced Micro Devices	31.9%
Intel	18.0%
GenRad	17.6%
Monolithic Memories	17.2%
Teradyne	16.6%
Applied Materials	16.5%
DSC Communications	15.2%
National Semiconductor	15.0%
Cray Research	14.7%
Tektronix	14.6%

Capital expenditures

(Percentage of net cash flow after dividends)

TOP 10	
National Semiconductor	5,082.6%
Scientific-Atlanta	1,731.5%
General Instrument	653.7%
Intel	382.6%
Varian Associates	354.9%
Emhart	314.1%
M/A-COM	294.3%
United Technologies	257.8%
General Dynamics	255.6%
Coherent	253.2%

BOTTOM 5	
Kollmorgen	-170.5%
Convergent Technologies	-310.1%
Allen Group	-319.4%
Pioneer-Standard Electronics	-546.5%
Augat	-1,064.3%

Foreign revenue

(Percentage of total revenue)

TOP 10	
Datapoint	69.6%
Tandon	69.4%
Molex	63.5%
Cray Research	53.8%
Polaroid	53.6%
Applied Materials	53.5%
Atari	53.2%
Foxboro	51.2%
Measurex	51.0%
IBM	50.5%

Ranking: 1 - 50

Rank 1986	Rank 1985	Company	Calendar year Electronics revenue ($ millions)	Calendar year Total revenue ($ millions)	Calendar year Net income ($ millions)	Fiscal year Total revenue ($ millions)	Fiscal year Net income ($ millions)	Return on equity	Return on investment
1	1	IBM	$51,250.0	$51,250.0	$4,789.0	$51,250.0	$4,789.0	13.9%	12.0%
2	2	AT&T	14,979.0	34,087.0	139.0	34,087.0	139.0	1.0%	0.6%
3	4	General Electric[1]	11,300.0	35,211.0	2,492.0	35,211.0	2,492.0	16.5%	11.7%
4	3	GM Hughes Electronics	10,440.0	10,440.0	445.1	10,440.0	445.1	6.7%	6.1%
5	6	DEC	8,414.3	8,414.3	861.6	7,590.4	617.4	10.8%	10.1%
6	5	Xerox	8,150.0	9,355.0	488.0	9,355.0	488.0	9.5%	6.8%
7	-	Unisys	7,432.4	7,432.4	-43.4	7,432.4	-43.4	-1.1%	-0.7%
8	9	Hewlett-Packard	7,245.0	7,245.0	523.0	7,102.0	516.0	11.8%	10.9%
9	23	Allied-Signal	6,132.9	11,794.0	605.0	11,794.0	605.0	16.4%	9.1%
10	35	Lockheed[2]	5,956.0	10,273.0	408.0	10,273.0	408.0	21.9%	11.8%
11	10	Motorola	5,888.0	5,888.0	194.0	5,888 0	194.0	7.0%	5.7%
12	8	Honeywell	5,378.2	5,378.2	12.9	5,378.2	12.9	0.6%	0.4%
13	13	Texas Instruments	4,974.0	4,974.0	39.9	4,974.0	39.9	2.3%	2.0%
14	15	NCR	4,466.7	4,881.6	336.5	4,881.6	336.5	14.0%	13.0%
15	16	Raytheon	4,343.0	7,308.0	393.2	7,308.0	393.2	20.1%	19.3%
16	18	Rockwell International	4,305.0	12,396.9	634.8	12,295.7	611.2	19.3%	15.7%
17	72	Eastman Kodak	3,850.0	11,550.0	374.0	11,550.0	374.0	5.9%	4.4%
18	20	North American Philips	3,440.0	4,531.6	68.5	4,531.6	68.5	6.2%	3.9%
19	21	Tandy	3,322.8	3,322.8	225.9	3,035.7	197.7	15.1%	11.8%
20	19	TRW	3,170.0	6,035.9	217.7	6,035.9	217.7	18.2%	9.3%
21	17	Control Data	2,682.8	3,346.7	-311.1	3,346.7	-311.1	-31.0%	-20.0%
22	25	Wang Laboratories	2,668.9	2,668.9	-86.4	2,642.5	50.9	3.5%	2.3%
23	22	Litton Industries	2,660.0	4,290.6	48.4	4,521.0	71.1	7.0%	5.6%
24	26	Westinghouse Electric	2,545.0	10,731.0	670.8	10,731.0	670.8	22.3%	16.3%
25	28	3M	2,460.0	8,602.0	779.0	8,602.0	779.0	17.5%	14.7%
26	29	Ford Motor	2,422.7	62,715.8	3,285.1	62,715.8	3,285.1	22.1%	18.0%
27	7	ITT	2,300.0	17,437.0	527.9	7,595.5	527.9	7.4%	5.2%
28	30	Martin Marietta	2,160.0	4,752.5	202.3	4,752.5	202.3	24.0%	18.8%
29	27	Harris	2,106.4	2,106.4	68.6	2,216.6	59.6	6.6%	5.4%
30	50	Grumman	2,075.0	3,440.1	78.7	3,440.1	78.7	10.3%	6.3%
31	34	Apple Computer	2,030.3	2,030.3	155.5	1,902.0	39.4	5.7%	5.7%
32	24	GTE	2,007.0	15,111.5	1,152.6	15,112.0	1,152.6	14.0%	6.5%
33	32	Boeing	1,975.0	16,341.0	665.0	16,341.0	665.0	13.8%	13.0%
34	36	Zenith Electronics	1,892.1	1,892.1	-10.0	1,892.1	-10.0	-2.3%	-1.2%
35	33	Eaton	1,800.0	3,811.6	137.6	3,811.6	137.6	10.9%	7.2%
36	38	Pitney Bowes	1,751.9	1,986.7	166.1	1,986.7	166.1	18.2%	14.3%
37	42	Du Pont	1,750.0	27,148.0	1,538.0	27,148.0	1,538.0	11.5%	8.4%
38	39	McDonnell Douglas	1,740.0	12,660.6	277.5	12,660.6	277.5	9.8%	7.2%
39	37	National Semiconductor	1,678.0	1,678.0	-57.0	1,478.1	-148.3	-20.7%	-17.5%
40	44	AMP	1,595.0	1,933.1	164.3	1,933.1	164.3	14.5%	12.4%
41	45	Singer	1,484.0	1,725.2	58.5	1,752.2	58.5	9.6%	6.2%
42	31	United Technologies	1,413.0	15,699.2	48.1	15,669.2	48.1	1.3%	0.8%
43	51	Teledyne	1,375.0	3,241.4	238.3	3,241.4	238.3	14.6%	10.8%
44	41	Tektronix	1,352.4	1,352.4	55.1	1,357.2	39.3	4.7%	4.2%
45	47	Emerson Electric	1,340.0	5,156.2	414.7	4,952.9	408.9	17.2%	14.2%
46	49	Data General	1,287.5	1,287.5	7.9	1,268.0	-29.0	-4.2%	-3.0%
47	48	Avnet	1,287.0	1,476.5	19.2	1,415.6	23.9	3.7%	3.1%
48	43	Intel	1,265.0	1,265.0	-183.3	1,265.0	-183.3	-14.4%	-10.9%
49	53	Northrop	1,247.9	5,608.4	41.2	5,608.4	41.2	4.6%	2.9%
50	46	Perkin-Elmer	1,182.0	1,303.4	62.1	1,290.6	72.6	10.3%	7.5%

Includes RCA results from June 1, 1986

[2] Includes Sanders Associates results from July 28, 1986

Cost of goods as a percentage of revenue	Fiscal year			Five-year growth (Compounded annual growth rate)		Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income				
37.8%	7.8%	$127.0	$11.9	12.0%	7.7%	85.4%	14.0%	50.5%	12/86
42.0%	6.7%	107.6	0.4	NA	NA	135.3%	35.8%	0.0%	12/86
70.2%	3.7%	98.1	6.9	5.3%	8.6%	70.6%	29.0%	21.4%	12/86
74.1%	3.9%	102.4	4.4	NA	NA	115.4%	8.2%	12.2%	12/86
51.4%	10.7%	80.2	6.5	18.9%	12.5%	56.3%	5.8%	41.9%	6/86
42.8%	6.9%	93.2	4.9	1.5%	-4.0%	108.2%	28.4%	40.4%	12/86
62.9%	5.9%	77.4	-0.5	NA	NA	221.1%	41.8%	42.9%	12/86
42.7%	11.6%	86.6	6.3	15.0%	11.1%	63.9%	7.2%	46.3%	10/86
74.1%	3.9%	86.1	4.4	16.9%	10.0%	113.1%	44.7%	20.9%	12/86
85.1%	4.8%	106.0	4.2	14.7%	21.4%	79.6%	46.1%	6.3%	12/86
54.1%	8.4%	62.4	2.1	12.0%	2.1%	103.9%	18.9%	38.2%	12/86
67.4%	4.6%	68.9	0.2	0.1%	-45.0%	190.9%	39.3%	21.7%	12/86
72.6%	8.2%	64.4	0.5	3.4%	-18.1%	110.0%	13.6%	25.8%	12/86
47.3%	6.6%	78.7	5.4	7.3%	10.1%	68.7%	7.1%	43.8%	12/86
76.7%	3.5%	97.4	5.2	6.3%	4.0%	69.7%	4.0%	7.1%	12/86
76.1%	3.3%	101.6	5.1	11.8%	13.9%	54.5%	18.6%	13.6%	9/86
57.5%	9.2%	95.1	3.1	2.2%	-21.3%	180.2%	24.5%	35.9%	12/86
74.0%	2.5%	89.9	1.4	8.4%	-2.7%	159.4%	37.1%	0.0%	12/86
44.9%	0.0%	84.3	5.5	12.4%	3.1%	21.7%	22.0%	2.6%	6/86
73.2%	2.6%	73.2	2.6	2.7%	-1.0%	112.1%	48.8%	25.3%	12/86
61.7%	9.4%	97.3	-9.0	1.5%	NA	-140.4%	35.7%	32.5%	12/86
46.9%	7.7%	83.5	1.6	25.3%	-8.2%	92.8%	33.3%	39.7%	6/86
76.0%	2.6%	81.5	1.3	2.6%	-25.6%	130.0%	19.7%	20.0%	7/86
69.0%	2.3%	91.5	5.7	2.8%	8.9%	52.5%	27.0%	18.7%	12/86
53.1%	6.6%	105.1	9.5	5.7%	3.0%	76.3%	16.0%	37.4%	12/86
78.0%	3.7%	164.0	8.6	10.4%	NA	59.3%	18.8%	31.8%	12/86
79.0%	7.1%	61.8	4.3	-15.2%	-5.4%	53.4%	29.1%	39.3%	12/86
76.8%	4.6%	69.4	3.0	12.1%	0.2%	91.1%	21.5%	0.0%	12/86
61.1%	5.3%	83.0	2.2	9.3%	-10.8%	73.4%	18.9%	6.9%	6/86
89.5%	2.3%	103.0	2.4	14.0%	1.3%	161.8%	38.5%	0.0%	12/86
44.2%	6.7%	339.6	7.0	41.5%	-23.9%	73.6%	0.0%	25.8%	9/86
63.3%	1.9%	94.5	7.2	7.5%	10.9%	115.5%	53.8%	14.1%	12/86
85.0%	4.6%	137.9	5.6	10.8%	7.1%	84.4%	5.4%	44.9%	12/86
81.8%	5.3%	51.1	-0.3	8.2%	NA	203.3%	46.4%	12.0%	12/86
72.6%	3.5%	87.7	3.2	6.0%	1.5%	71.5%	34.5%	19.4%	12/86
30.9%	2.7%	68.1	5.7	3.8%	19.2%	88.0%	21.4%	17.3%	12/86
47.9%	4.3%	192.2	10.9	58.6%	12.7%	94.0%	27.0%	36.7%	12/86
79.5%	4.0%	119.8	2.6	11.4%	9.5%	109.7%	26.0%	22.2%	12/86
63.5%	15.0%	48.0	-4.8	5.9%	NA	5,082.6%	15.2%	37.9%	5/86
59.2%	8.8%	88.7	7.5	9.4%	4.0%	72.7%	14.4%	40.1%	12/86
79.7%	2.4%	62.6	2.1	-8.3%	8.8%	79.2%	35.4%	0.0%	12/86
75.9%	5.4%	81.0	0.2	4.4%	-36.3%	257.8%	39.5%	30.6%	12/86
75.1%	2.6%	72.4	5.3	0.0%	-10.4%	29.0%	26.0%	9.0%	12/86
42.7%	14.6%	78.2	2.3	5.0%	-13.3%	66.2%	10.3%	38.8%	5/86
61.5%	3.1%	81.6	6.7	7.6%	8.4%	41.0%	17.7%	17.4%	9/86
50.9%	11.3%	81.5	-1.9	11.5%	NA	203.8%	28.7%	36.4%	9/86
73.5%	0.0%	153.0	2.6	5.7%	-16.1%	75.4%	15.1%	0.0%	6/86
50.3%	18.0%	69.5	-10.1	9.9%	NA	382.6%	23.8%	39.9%	12/86
84.9%	6.7%	119.8	0.9	17.8%	50.1%	172.6%	37.2%	0.0%	12/86
52.5%	8.1%	88.5	5.0	3.0%	-1.5%	72.0%	26.7%	39.1%	7/86

FINANCIAL TABLES

Ranking: 51 - 100

Rank 1986	Rank 1985	Company	Calendar year: Electronics revenue ($ millions)	Calendar year: Total revenue ($ millions)	Calendar year: Net income ($ millions)	Fiscal year: Total revenue ($ millions)	Fiscal year: Net income ($ millions)	Return on equity	Return on investment
51	59	E-Systems	$1,008.8	$1,145.5	$61.6	$1,145.5	$61.6	16.3%	13.8%
52	56	Amdahl	966.3	966.3	39.3	966.3	39.3	7.9%	5.7%
53	40	Gould	908.8	908.8	34.6	908.8	34.6	6.2%	3.6%
54	65	Contel	900.0	3,074.0	232.9	3,074.0	232.6	15.3%	6.6%
55	68	General Dynamics	900.0	8,892.0	-62.6	8,892.0	-62.6	5.0%	-3.7%
56	52	Varian Associates	893.4	893.4	-8.8	891.1	-14.9	-3.6%	-3.0%
57	58	General Instrument	871.7	871.7	16.2	794.3	-66.5	-12.1%	-11.3%
58	60	Prime Computer	860.2	860.2	46.9	860.2	46.9	10.7%	10.3%
59	61	Chrysler	860.0	22,586.3	1,403.6	22,586.3	1,403.6	26.3%	17.8%
60	69	Tandem Computers	835.8	835.8	79.2	767.8	63.8	11.9%	11.7%
61	67	Johnson Controls	833.0	2,535.2	83.2	2,639.4	95.9	11.6%	9.0%
62	64	Telex	817.0	817.0	72.7	695.0	67.5	25.0%	16.4%
63	79	Emerson Radio	770.6	770.6	28.4	566.3	12.9	21.0%	8.3%
64	55	General Signal	754.3	1,583.4	74.6	1,583.4	74.9	8.1%	7.1%
65	63	Penn Central	730.0	2,387.9	154.2	2,387.9	154.2	7.4%	7.0%
66	100	Seagate Technology	709.5	709.5	90.4	459.8	34.5	16.6%	15.4%
67	66	Storage Technology	696.0	696.0	16.8	696.0	16.8	NA	NA
68	73	Loral	683.6	683.6	56.6	663.8	53.0	17.1%	12.0%
69	78	COMPAQ Computer	625.2	625.2	42.9	625.2	42.9	23.4%	16.7%
70	71	SmithKline Beckman	619.6	3,745.4	521.1	3,745.4	521.1	40.2%	31.8%
71	70	Advanced Micro Devices	615.2	615.2	-103.9	576.1	-36.6	-9.4%	-8.6%
72	76	Intergraph	605.7	605.7	70.4	605.7	70.4	14.2%	13.7%
73	88	Cray Research	596.7	596.7	124.8	596.7	124.8	28.2%	21.7%
74	74	Corning Glass Works	580.5	1,856.3	162.2	1,856.3	162.2	12.0%	9.5%
75	57	M/A-COM	577.6	577.6	-21.9	577.5	8.8	1.9%	1.4%
76	81	Tracor	577.0	632.1	18.8	632.1	18.8	8.8%	5.1%
77	77	Monsanto	540.0	6,879.0	433.0	6,879.0	433.0	11.5%	7.5%
78	80	Arrow Electronics	501.8	529.6	-28.3	529.6	-28.3	-27.6%	-17.9%
79	84	Computervision	494.7	494.7	-5.8	494.7	-5.8	-3.2%	-1.7%
80	75	SCI Systems	487.9	487.9	14.6	470.2	13.8	12.0%	7.0%
81	83	Scientific-Atlanta	479.6	479.6	-7.4	469.1	-9.2	-5.1%	-4.3%
82	82	United Telecommunications	460.3	3,058.8	187.2	3,058.8	187.2	10.7%	4.1%
83	-	Textron	445.0	5,023.3	241.6	5,023.3	241.6	13.1%	6.0%
84	124	Xidex	419.0	533.5	32.6	432.3	32.2	6.6%	5.5%
85	87	Medtronic	397.0	469.2	69.8	402.8	67.4	19.3%	16.9%
86	101	Apollo Computer	391.7	391.7	9.3	391.7	9.3	4.9%	3.0%
87	90	Ducommun	386.6	455.2	-19.2	455.2	-19.2	-36.2%	-9.3%
88	95	Tyler	384.3	961.4	11.9	961.4	11.9	6.6%	3.1%
89	122	Western Digital	352.8	352.8	32.4	279.4	21.5	22.8%	13.0%
90	89	Dataproducts	350.8	350.8	14.6	353.8	-26.8	-12.5%	-9.8%
91	110	Molex	349.4	349.4	38.9	291.9	32.0	12.6%	12.0%
92	85	Compugraphic	341.1	341.1	3.4	341.1	3.4	1.7%	1.5%
93	-	Sun Microsystems	341.1	341.1	24.5	210.1	11.9	11.0%	9.4%
94	94	Diebold	340.0	413.7	34.9	413.7	34.9	10.9%	10.6%
95	97	Analog Devices	336.1	336.1	20.2	334.4	23.4	8.7%	7.6%
96	91	EG&G	325.0	1,145.1	44.9	1,145.1	44.9	19.0%	15.2%
97	99	Cubic	318.0	344.9	2.5	337.8	1.1	1.0%	0.7%
98	93	Datapoint	317.3	317.3	-67.3	325.2	-15.4	-6.6%	-4.5%
99	143	AM International	317.0	959.7	0.7	688.9	2.4	1.0%	0.4%
100	92	Teradyne	306.1	306.1	0.2	306.1	0.2	0.1%	0.1%

Cost of goods as a percentage of revenue	Fiscal year			Five-year growth (Compounded annual growth rate)		Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income				
80.5%	0.0%	$76.4	$4.1	14.9%	20.9%	67.3%	15.4%	6.9%	12/86
50.7%	12.3%	134.2	5.5	16.9%	8.0%	100.4%	27.0%	43.5%	12/86
47.8%	10.8%	85.6	3.3	-4.4%	-11.0%	68.6%	41.2%	19.3%	12/86
32.3%	0.0%	133.1	10.1	12.8%	10.1%	128.5%	57.2%	0.0%	12/86
79.3%	3.0%	84.4	-0.6	13.9%	NA	255.6%	25.5%	0.0%	12/86
68.6%	9.2%	76.8	-1.3	7.3%	NA	354.9%	16.5%	22.8%	9/86
76.7%	5.2%	38.7	-3.2	-0.8%	NA	653.7%	6.4%	19.0%	2/86
40.1%	10.7%	99.8	5.4	18.7%	4.5%	83.1%	4.1%	47.2%	12/86
80.1%	3.2%	196.3	12.2	17.8%	NA	116.4%	32.2%	28.1%	12/86
26.7%	11.3%	134.3	11.1	29.8%	19.2%	60.8%	2.3%	39.6%	9/86
76.7%	1.5%	98.1	3.6	18.5%	14.8%	78.6%	22.2%	12.9%	9/86
51.0%	5.5%	94.1	9.1	30.1%	52.9%	98.3%	34.2%	15.6%	3/86
88.4%	0.1%	821.9	18.7	45.2%	NA	21.1%	60.5%	0.0%	3/86
66.6%	6.2%	79.2	3.7	-1.4%	-8.5%	54.5%	12.5%	11.4%	12/86
53.9%	1.4%	98.3	6.3	-6.5%	-1.8%	42.6%	4.7%	17.3%	12/86
76.2%	4.1%	51.7	3.9	115.9%	82.9%	71.9%	7.0%	36.7%	6/86
59.7%	8.9%	80.9	2.0	-5.5%	-27.2%	27.7%	NA	20.3%	12/86
81.5%	4.7%	81.0	6.5	22.8%	18.7%	65.7%	30.2%	0.0%	3/86
55.3%	4.3%	284.2	19.5	NA	NA	87.7%	28.4%	19.1%	12/86
30.9%	10.1%	111.0	15.4	10.2%	5.2%	45.4%	21.0%	34.9%	12/86
40.8%	31.9%	43.0	-2.7	13.2%	NA	179.7%	9.0%	23.9%	3/86
46.1%	9.5%	106.3	12.3	46.1%	53.5%	85.8%	3.7%	34.2%	12/86
24.5%	14.7%	149.2	31.2	42.5%	47.0%	65.7%	23.0%	53.8%	12/86
58.7%	5.6%	74.0	6.5	3.0%	10.7%	99.2%	20.7%	30.4%	12/86
63.0%	5.9%	64.0	1.0	3.1%	-27.4%	294.3%	30.1%	10.2%	9/86
72.8%	2.4%	60.2	1.8	11.2%	-0.2%	100.9%	41.8%	8.8%	12/86
51.8%	7.6%	133.0	8.4	-0.2%	-0.5%	51.3%	34.8%	32.6%	12/86
77.5%	0.0%	249.2	-13.3	8.0%	NA	-8.9%	35.0%	0.0%	12/86
46.9%	9.4%	103.6	-1.2	12.8%	NA	47.9%	46.4%	29.7%	12/86
92.6%	0.0%	90.7	2.7	51.3%	34.8%	49.7%	41.6%	21.1%	6/86
71.3%	5.9%	134.0	-2.6	11.1%	NA	1,731.5%	15.2%	16.0%	6/86
49.4%	0.4%	131.6	8.1	6.8%	-4.7%	176.0%	61.7%	0.0%	12/86
77.5%	2.1%	69.8	3.4	8.6%	9.7%	63.3%	54.5%	0.0%	12/86
65.1%	2.5%	66.5	5.0	42.6%	36.6%	80.9%	16.6%	24.7%	6/86
29.2%	9.6%	80.6	13.5	7.1%	10.8%	6.3%	12.8%	37.7%	4/86
46.4%	11.4%	109.5	2.6	158.4%	NA	110.3%	38.3%	47.8%	12/86
78.4%	0.0%	189.7	-8.0	21.5%	NA	-86.5%	74.5%	0.0%	12/86
74.0%	0.0%	127.8	1.6	13.1%	-10.5%	105.8%	52.2%	0.0%	12/86
58.7%	8.8%	113.2	8.7	63.5%	NA	47.2%	43.1%	33.0%	6/86
70.0%	8.8%	84.2	-6.4	4.2%	NA	-51.6%	21.7%	23.3%	3/86
45.3%	5.9%	66.3	7.3	15.3%	14.9%	69.6%	4.5%	63.5%	6/86
49.6%	11.3%	85.4	0.8	4.3%	NA	80.5%	15.0%	24.8%	12/86
45.9%	14.6%	103.4	5.9	NA	NA	206.4%	14.7%	20.5%	6/86
62.5%	3.0%	77.8	6.6	1.4%	3.8%	54.0%	2.4%	5.0%	12/86
36.8%	13.5%	67.4	4.7	16.4%	38.5%	71.0%	12.6%	47.3%	10/86
81.7%	1.4%	49.8	2.0	9.1%	5.0%	42.5%	20.2%	6.3%	12/86
77.9%	1.7%	75.1	0.3	8.2%	-36.7%	139.5%	32.2%	0.0%	9/86
42.6%	7.0%	89.8	-4.3	-3.9%	NA	122.6%	31.2%	69.6%	7/86
59.9%	3.0%	54.2	0.2	1.7%	NA	85.0%	56.7%	32.5%	7/86
48.9%	16.6%	71.2	0.1	13.9%	-44.5%	114.4%	6.6%	34.0%	12/86

Ranking: 101 - 150

Rank			Calendar year			Fiscal year			
1986	1985	Company	Electronics revenue ($ millions)	Total revenue ($ millions)	Net income ($ millions)	Total revenue ($ millions)	Net income ($ millions)	Return on equity	Return on investment
101	86	Convergent Technologies	$305.8	$305.8	-$32.8	$305.8	-$32.8	-14.9%	-13.7%
102	102	DSC Communications	304.0	304.0	11.0	304.0	11.0	5.5%	3.3%
103	96	TIE/communications	298.2	298.2	-59.3	298.2	-59.3	-37.9%	-25.5%
104	103	Foxboro	293.8	544.0	7.1	544.0	7.1	2.6%	2.3%
105	116	Dynatech	288.9	288.9	23.8	256.7	20.4	21.4%	17.7%
106	-	Lotus Development	282.9	282.9	48.3	282.9	48.3	42.1%	32.8%
107	106	Kollmorgen	278.0	319.2	-19.9	319.2	-19.9	-25.1%	-13.8%
108	98	Savin	272.0	362.7	-11.1	362.7	-11.1	11.8%	-10.2%
109	120	Marshall Industries	269.2	269.2	4.5	244.8	2.9	5.2%	2.9%
110	108	Premier Industrial	268.0	442.5	41.7	435.0	41.4	17.3%	16.7%
111	107	Dover	263.5	1,439.8	83.8	1,439.8	83.8	13.4%	10.6%
112	112	Paradyne	261.1	261.1	-38.5	261.1	-38.5	-26.3%	-0.5%
113	111	Augat	260.4	260.4	-8.7	260.4	-8.7	-4.4%	-3.6%
114	-	Microsoft	260.2	260.2	57.7	197.5	39.3	28.2%	28.2%
115	-	Atari	258.1	258.1	25.1	258.1	25.1	23.8%	23.3%
116	131	LTV	257.0	7,271.4	-3,251.6	7,271.4	-3,251.6	NA	NA
117	117	Bally Manufacturing	256.0	1,592.8	23.7	1,592.8	23.7	4.8%	1.3%
118	119	Watkins-Johnson	255.4	255.4	17.2	255.4	17.2	16.8%	13.3%
119	105	Emhart	255.0	2,094.3	-10.2	2,094.3	-10.2	-1.4%	-0.8%
120	145	Nashua	254.0	704.2	20.6	704.2	20.6	11.8%	9.3%
121	114	Square D	252.6	1,403.5	98.9	1,403.5	98.9	14.7%	11.6%
122	115	Union Carbide	248.0	6,343.0	130.0	6,343.0	130.0	12.9%	2.9%
123	125	Eli Lilly	247.0	3,702.4	558.2	3,720.4	558.2	20.4%	16.6%
124	147	Recognition Equipment	246.6	246.6	9.7	241.8	10.5	9.1%	6.0%
125	109	CTS	245.5	245.5	-26.6	245.5	-26.6	-22.8%	-16.0%
126	160	Polaroid	244.0	1,629.2	103.5	1,629.2	103.5	10.4%	8.9%
127	123	Tandon	242.8	242.8	-62.6	214.1	-62.8	-122.7%	-101.4%
128	136	Cincinnati Milacron	242.0	850.0	23.3	850.0	23.3	8.1%	4.6%
129	132	Figgie International	240.8	919.8	42.4	919.8	42.4	14.5%	10.4%
130	-	BRIntec	232.0	310.7	11.8	310.7	11.8	21.5%	8.6%
131	-	Wyse Technology	228.4	228.4	16.7	166.4	12.6	17.5%	15.5%
132	-	Reynolds & Reynolds	227.0	452.5	23.4	404.0	23.9	13.4%	9.2%
133	126	Cooper Industries	226.0	3,433.3	147.7	3,433.3	147.7	10.4%	6.2%
134	138	Wyle Laboratories	224.6	307.0	4.3	307.0	4.3	5.3%	4.8%
135	150	Sundstrand	220.0	1,433.9	45.4	1,433.9	45.4	7.5%	4.9%
136	164	Diasonics	217.1	217.1	-17.4	217.1	-17.4	-22.7%	-18.8%
137	135	Pioneer-Standard	214.2	214.2	-0.4	202.0	-2.1	-7.0%	-2.4%
138	-	Micropolis	213.1	213.1	18.3	213.1	18.3	16.5%	16.5%
139	134	Gerber Scientific	213.0	213.0	19.7	191.8	18.2	12.9%	10.4%
140	154	Monolithic Memories	213.0	213.0	9.9	204.9	8.9	4.0%	3.8%
141	-	Ashton-Tate	210.8	210.8	30.1	210.8	30.1	24.6%	22.9%
142	137	Spectra-Physics	208.8	208.8	0.9	210.1	0.8	0.6%	0.5%
143	130	Fluke	208.5	208.5	11.6	209.0	12.2	9.8%	8.5%
144	140	Avantek	208.2	208.2	16.1	208.2	16.1	10.9%	10.9%
145	142	Logicon	204.5	204.5	9.3	198.4	10.0	19.1%	19.1%
146	127	GenRad	204.3	204.3	-29.9	204.3	-29.9	-28.3%	-16.7%
147	133	Andrew	198.0	198.0	9.5	197.7	9.5	6.6%	5.7%
148	-	Bolt Beranek and Newman	196.6	196.6	12.9	178.0	11.3	14.4%	13.4%
149	148	AVX	195.4	195.4	-3.1	195.4	-3.1	-2.0%	-1.5%
150	152	Decision Industries	195.1	195.1	7.8	195.1	7.8	8.0%	7.8%

	Fiscal year			Five-year growth (Compounded annual growth rate)					
Cost of goods as a percentage of revenue	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income	Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
68.3%	10.7%	$124.2	-$13.3	87.8%	NA	-310.1%	8.2%	14.0%	12/86
51.8%	15.2%	128.5	4.7	53.5%	NA	51.7%	40.3%	0.0%	12/86
73.9%	7.7%	175.4	-34.9	17.9%	NA	-5.4%	32.8%	25.7%	12/86
57.6%	8.6%	69.3	0.9	-2.2%	-30.9%	84.3%	9.5%	51.2%	12/86
40.9%	8.6%	100.7	8.0	25.1%	30.8%	43.9%	17.4%	22.9%	3/86
14.3%	11.5%	199.1	34.0	NA	NA	25.4%	22.2%	42.6%	12/86
72.9%	5.2%	77.8	-4.9	7.3%	NA	-170.5%	45.1%	7.7%	12/86
55.5%	1.7%	138.3	-4.2	-4.8%	NA	78.7%	186.9%	0.0%	12/86
75.1%	0.0%	226.0	2.6	15.7%	NA	223.4%	44.0%	0.0%	5/86
52.3%	0.6%	120.8	11.5	6.5%	5.0%	16.2%	3.2%	0.0%	5/86
67.5%	3.0%	87.1	5.1	7.0%	-2.7%	33.5%	20.6%	14.6%	12/86
60.7%	7.4%	75.5	-11.1	14.0%	NA	-165.1%	98.0%	11.0%	12/86
70.1%	6.4%	70.3	-2.4	5.1%	NA	-1,064.3%	19.5%	18.5%	12/86
17.8%	10.4%	171.3	34.0	NA	NA	31.3%	0.0%	24.0%	6/86
57.3%	5.6%	184.4	17.9	NA	NA	3.3%	1.9%	53.2%	12/86
86.1%	NA	150.5	-67.3	0.6%	NA	-5.8%	-8.9%	0.0%	12/86
67.3%	1.0%	75.4	1.1	12.9%	-21.9%	115.2%	72.7%	0.0%	12/86
59.3%	6.4%	81.1	5.5	14.0%	20.9%	56.7%	20.8%	14.2%	12/86
63.5%	2.1%	61.3	-0.3	3.7%	NA	314.1%	40.8%	45.8%	12/86
65.0%	1.0%	121.4	3.6	3.3%	NA	45.3%	21.3%	42.6%	12/86
62.6%	3.0%	68.5	4.8	4.9%	-1.3%	86.6%	21.3%	17.3%	12/86
61.3%	2.3%	126.1	2.6	-9.0%	-27.5%	119.4%	77.8%	28.2%	12/86
31.4%	11.5%	127.8	19.2	6.1%	8.3%	58.4%	18.6%	34.7%	12/86
56.4%	4.8%	82.0	3.6	13.0%	NA	59.1%	34.4%	46.0%	10/86
77.2%	0.0%	127.6	-13.8	5.7%	NA	-156.8%	29.9%	17.2%	12/86
52.2%	7.8%	110.3	7.0	2.8%	27.2%	57.7%	14.7%	53.6%	12/86
86.3%	7.9%	75.1	-22.0	31.6%	NA	-17.0%	17.4%	69.4%	9/86
74.1%	4.7%	88.6	2.4	-1.9%	-17.4%	85.0%	42.8%	29.9%	12/86
74.3%	1.7%	56.4	2.6	4.8%	11.7%	53.2%	28.0%	0.0%	12/86
72.7%	1.9%	70.6	2.7	3.6%	NA	39.3%	59.8%	12.4%	12/86
64.8%	5.4%	118.6	9.0	NA	NA	61.2%	11.4%	13.5%	3/86
49.4%	0.0%	74.4	4.4	9.7%	22.8%	48.9%	31.3%	8.7%	9/86
63.3%	0.8%	85.4	3.7	3.7%	-9.3%	55.4%	40.1%	20.6%	12/86
75.7%	0.0%	163.9	2.3	7.9%	22.0%	136.0%	10.3%	0.0%	1/87
61.1%	4.6%	89.6	2.8	6.5%	-13.7%	144.1%	34.4%	23.1%	12/86
58.7%	6.3%	157.0	-12.6	23.5%	NA	-79.1%	17.1%	26.0%	12/86
76.5%	0.0%	215.8	-2.2	17.1%	NA	-546.5%	66.2%	0.0%	3/86
71.8%	5.2%	118.9	10.2	54.9%	136.4%	60.7%	0.0%	17.7%	12/86
44.3%	9.3%	112.8	10.7	15.5%	16.4%	31.6%	19.0%	33.4%	4/86
44.9%	17.2%	48.8	2.1	21.8%	5.0%	87.8%	4.4%	26.2%	9/86
12.7%	9.2%	191.6	27.4	125.1%	NA	21.6%	7.0%	28.2%	1/87
56.8%	8.5%	83.1	0.3	9.1%	-19.6%	155.2%	19.9%	48.1%	9/86
41.3%	11.5%	83.6	4.9	8.4%	7.5%	41.8%	13.3%	38.1%	9/86
50.5%	12.2%	67.0	5.2	20.5%	11.1%	71.7%	0.1%	14.0%	12/86
83.2%	0.5%	80.8	4.1	21.0%	29.8%	32.8%	0.0%	0.0%	3/86
46.1%	17.6%	91.2	-13.3	3.8%	NA	-84.6%	40.9%	42.4%	12/86
62.0%	6.7%	84.8	4.1	11.6%	-0.7%	47.6%	14.0%	32.3%	9/86
55.9%	4.8%	84.3	5.4	26.5%	64.5%	88.1%	7.1%	0.0%	6/86
72.3%	2.8%	38.3	-0.6	9.8%	NA	83.1%	27.2%	34.7%	12/86
61.9%	5.2%	121.9	4.8	31.2%	30.4%	53.3%	3.0%	27.0%	11/86

Ranking: 151 - 200

Rank 1986	Rank 1985	Company	Calendar year Electronics revenue ($ millions)	Calendar year Total revenue ($ millions)	Calendar year Net income ($ millions)	Fiscal year Total revenue ($ millions)	Fiscal year Net income ($ millions)	Return on equity	Return on investment
151	176	LSI Logic	$194.3	$194.3	$3.9	$194.3	$3.9	1.5%	1.1%
152	151	Measurex	192.7	192.7	21.1	192.7	21.1	13.9%	13.3%
153	144	Bell Industries	192.0	319.1	3.2	300.2	3.0	2.9%	2.5%
154	139	Micom Systems	191.6	191.6	9.5	189.5	10.8	6.8%	6.4%
155	128	Bell & Howell	190.0	853.4	32.9	853.4	32.9	12.1%	7.0%
156	146	General DataComm	189.2	189.2	3.9	178.0	3.9	4.6%	2.6%
157	141	Ball	187.5	1,070.3	58.9	1,070.3	58.9	16.1%	12.0%
158	-	MiniScribe	184.9	184.9	20.3	184.9	20.3	30.6%	22.3%
159	121	NBI	181.0	283.1	-10.4	282.4	-3.9	-3.6%	-2.1%
160	167	Cipher Data Products	180.8	180.8	7.5	163.0	7.2	5.4%	5.4%
161	187	Electrospace Systems	179.9	179.9	10.0	145.0	13.4	26.0%	22.7%
162	166	Kidde	175.0	2,356.2	52.2	2,356.2	52.2	7.2%	4.2%
163	162	ADT	174.3	519.2	22.3	519.2	22.3	16.2%	11.8%
164	180	Mentor Graphics	173.5	173.5	11.0	173.5	11.0	7.1%	6.2%
165	161	Allen Group	173.0	423.2	-8.6	423.2	-8.6	-5.8%	-4.1%
166	170	Veeco Instruments	170.7	170.7	0.5	167.8	0.4	0.4%	0.3%
167	-	Ametek	170.0	568.5	36.6	568.4	36.6	15.8%	9.4%
168	155	AST Research	168.9	168.9	17.3	172.3	27.2	31.4%	31.0%
169	179	Sun Electric	167.0	186.0	2.5	177.0	1.9	27.5%	3.4%
170	189	Analogic	166.5	166.5	17.3	148.2	10.1	6.4%	5.9%
171	163	Tyco Laboratories	166.0	1,037.6	42.6	796.4	37.5	17.8%	9.5%
172	-	Ultimate	163.0	163.0	13.9	139.9	14.4	30.0%	20.5%
173	158	ISC Systems	162.4	162.4	10.8	166.1	13.9	14.7%	12.0%
174	-	Genicom	157.5	157.5	8.6	157.5	8.6	18.9%	12.9%
175	-	Data Card	157.0	182.5	2.1	153.6	10.6	13.7%	12.5%
176	-	Digital Communications	156.9	156.9	22.9	137.9	20.6	17.3%	17.3%
177	174	International Rectifier	151.7	151.7	0.2	145.2	-1.8	-3.1%	-1.1%
178	159	Applied Materials	151.5	151.5	-0.5	149.3	1.2	1.3%	1.0%
179	173	Esterline	151.0	233.6	0.6	235.9	0.9	0.9%	0.6%
180	-	Mark IV Industries	151.0	244.8	9.1	259.8	6.3	21.6%	3.5%
181	169	Becton, Dickinson & Co.	150.0	1,389.7	124.8	1,311.6	111.9	13.9%	8.3%
182	157	Unitrode	149.4	149.4	-7.0	149.4	-7.0	-5.6%	-5.2%
183	193	Dynascan	146.8	146.8	6.1	146.8	6.1	16.2%	8.2%
184	-	Maxtor	147.9	147.9	22.2	85.2	10.7	23.3%	21.1%
185	175	Mark Controls	145.0	262.7	1.5	262.7	1.5	3.2%	2.3%
186	-	ADC Telecommunications	144.9	144.9	11.4	143.7	12.0	19.8%	18.7%
187	-	Intelligent Systems	143.5	143.5	1.8	125.5	0.0	0.1%	0.1%
188	-	UCCEL	141.6	141.6	17.2	141.6	17.2	13.3%	8.4%
189	195	Burndy	140.0	242.1	9.5	242.1	9.5	6.9%	4.9%
190	153	Pittway	140.0	585.7	27.6	585.7	27.6	9.8%	8.5%
191	-	Sun Chemical	140.0	371.4	26.1	371.4	26.1	4.1%	2.7%
192	190	Altos Computer Systems	139.5	139.5	19.1	134.2	20.3	19.8%	18.7%
193	181	Coherent	138.4	138.4	-0.2	138.2	-0.9	-1.1%	-0.8%
194	-	Applied Magnetics	137.0	137.0	4.4	128.1	4.1	4.1%	4.0%
195	185	United Industrial	137.0	272.5	-9.2	272.5	-9.2	-9.8%	-7.3%
196	188	Aydin	136.8	136.8	7.0	136.8	7.0	11.6%	10.7%
197	177	Fairchild Industries	134.0	643.3	7.6	643.3	7.6	4.1%	2.2%
198	-	Anthem Electronics	132.7	132.7	2.8	104.5	3.1	7.5%	7.5%
199	-	Olin	132.0	1,707.3	75.2	1,707.3	75.2	11.5%	7.0%
200	-	Thomas & Betts	132.0	347.4	38.0	347.4	38.0	15.5%	13.6%

Cost of goods as a percentage of revenue	Fiscal year			Five-year growth (Compounded annual growth rate)		Capital outlays to net cash flow after dividends	Debt as a percentage of total capital	Foreign revenue as a percentage of total revenue	Fiscal year ended
	R&D as a percentage of revenue	Revenue per employee ($ thousands)	Net income per employee ($ thousands)	Revenue	Net income				
50.4%	11.1%	$106.7	$2.1	NA	NA	200.5%	30.2%	21.2%	12/86
51.3%	7.3%	77.4	8.5	10.0%	58.6%	28.7%	4.1%	51.0%	11/86
74.5%	0.0%	158.0	1.6	9.5%	-18.0%	162.7%	11.7%	0.0%	6/86
44.8%	8.4%	93.3	5.3	39.1%	20.7%	44.1%	6.0%	27.7%	3/86
58.4%	5.1%	72.8	2.8	4.0%	13.7%	69.7%	42.2%	25.4%	12/86
55.9%	11.0%	70.7	1.6	25.3%	16.4%	131.3%	44.7%	23.2%	9/85
77.4%	1.6%	118.9	6.5	5.6%	15.0%	89.4%	25.3%	0.0%	12/86
71.1%	4.6%	NA	NA	369.6%	NA	79.0%	27.2%	22.0%	12/86
51.6%	4.4%	86.3	-1.2	37.4%	NA	128.5%	41.6%	6.5%	6/86
63.4%	9.2%	65.6	2.9	47.4%	NA	56.4%	0.0%	30.9%	6/86
81.4%	2.4%	71.1	6.6	26.1%	36.7%	85.0%	12.8%	0.0%	3/86
71.9%	0.9%	62.0	1.4	3.0%	-12.1%	88.8%	41.9%	10.7%	12/86
61.6%	1.2%	56.3	2.4	6.2%	-2.2%	139.8%	27.1%	17.3%	12/86
50.7%	9.7%	190.9	12.1	NA	NA	52.3%	11.8%	44.0%	12/86
66.7%	0.0%	78.4	-1.6	9.4%	NA	-319.4%	28.9%	37.9%	12/86
59.9%	7.4%	67.1	0.2	8.6%	-48.2%	247.7%	18.1%	44.0%	9/86
72.2%	4.0%	90.2	5.8	4.9%	6.7%	58.5%	40.6%	10.7%	12/86
42.5%	4.9%	215.4	34.0	375.3%	377.0%	21.2%	1.1%	27.8%	6/86
53.3%	3.2%	70.6	0.8	0.0%	NA	48.3%	87.6%	31.5%	10/86
51.3%	12.4%	80.1	5.4	11.5%	3.9%	45.9%	8.4%	42.4%	7/86
75.7%	0.9%	79.6	3.8	17.2%	10.7%	50.8%	47.0%	6.0%	5/86
50.2%	0.0%	310.9	32.1	55.4%	71.8%	29.8%	31.6%	16.9%	4/86
49.5%	9.0%	90.2	7.5	38.7%	25.5%	34.8%	18.1%	0.0%	6/86
61.6%	3.9%	63.0	3.4	NA	NA	30.8%	31.5%	20.1%	12/86
54.3%	5.8%	79.5	5.5	16.3%	12.5%	75.0%	8.4%	28.8%	3/86
30.7%	11.3%	156.1	23.3	69.8%	207.4%	33.9%	0.0%	17.3%	6/86
66.2%	6.4%	63.1	-0.8	10.1%	NA	186.2%	65.9%	46.4%	6/86
54.4%	16.5%	105.5	0.9	13.5%	-21.9%	128.2%	23.4%	53.5%	10/86
60.5%	4.8%	75.4	0.3	1.1%	-45.3%	142.9%	34.9%	37.7%	10/86
63.4%	2.5%	65.0	1.6	NA	NA	18.0%	83.8%	0.0%	2/1/86
47.8%	5.4%	68.0	5.8	4.2%	8.1%	92.7%	40.5%	28.9%	9/86
58.3%	8.2%	55.2	-2.6	4.8%	NA	249.4%	8.1%	20.0%	1/87
71.5%	1.6%	215.9	8.9	17.1%	14.9%	26.0%	49.6%	5.1%	12/86
65.8%	7.0%	87.1	10.9	NA	NA	61.2%	9.6%	25.2%	3/86
66.5%	1.7%	98.1	0.6	-0.9%	-20.7%	65.8%	29.3%	0.0%	12/86
46.6%	9.0%	83.1	6.9	25.3%	31.8%	53.3%	5.7%	10.4%	10/86
62.7%	4.6%	194.6	0.1	46.2%	-53.9%	97.5%	27.1%	20.1%	3/86
19.6%	9.0%	107.3	13.0	-0.6%	12.2%	41.5%	36.7%	20.6%	12/86
60.9%	3.9%	63.1	2.5	-1.2%	-22.1%	33.8%	29.8%	42.0%	12/86
59.7%	0.0%	81.4	3.8	7.7%	-4.3%	104.4%	13.5%	16.0%	12/86
70.0%	3.0%	23.7	1.7	-9.1%	-5.7%	54.4%	34.5%	24.6%	12/86
57.9%	8.0%	186.9	28.2	44.4%	53.5%	11.0%	5.6%	35.0%	6/86
61.6%	10.7%	99.3	-0.6	14.7%	NA	253.2%	23.4%	42.7%	9/86
65.4%	13.2%	31.5	1.0	13.6%	-6.7%	80.8%	1.5%	33.9%	9/86
89.6%	1.3%	67.3	-2.3	12.7%	NA	-99.6%	25.4%	4.4%	12/86
62.8%	5.5%	68.4	3.5	6.4%	1.9%	22.2%	7.7%	28.1%	12/86
73.1%	1.7%	57.4	0.7	-12.6%	-33.5%	130.7%	47.9%	7.3%	12/86
77.0%	0.0%	394.5	11.9	23.6%	7.4%	21.9%	0.0%	0.0%	3/86
70.7%	3.3%	129.3	5.7	-0.3%	-0.4%	84.4%	39.5%	6.1%	12/86
44.6%	4.8%	108.6	11.9	37.7%	32.3%	79.6%	12.3%	37.9%	12/86

The billion-dollar club

Fifty-one companies now belong to the ranks of those having more than $1 billion in electronics sales

IBM

1 IBM is the electronics industry personified. When the Armonk, N.Y., giant reported declines in earnings quarter after quarter last year, and a 26.9% drop for the total year, the world shuddered. No other indicator was needed to prove that the entire industry was in a serious slump.

In addition to slow capital spending, IBM reported unsatisfactory levels of demand for parts of its product line last year. And while the monolith has yet to enjoy an upswing in sales that some of its closest competitors have experienced, 1987 got off with a Big Blue bang.

First quarter results were better than expected. Sales of its 3090 mainframe computers reportedly have picked up. IBM's new midrange offering, the 9370 Information System, promises to fill the company's weakest product gap this year. And Big Blue's next generation personal computer, the Personal System/2, announced in a gala event that spanned the East Coast from Miami to Boston, has thrust IBM, after a low-profile year, back onto center stage.

AT&T

2 Chairman James E. Olson has two words to describe his top priority at AT&T: improve earnings. Indeed, AT&T's net income of $139 million on revenue of $34 billion last year was nothing to phone home about.

The company's finances should look better this year. In a major expense-slashing program, Olson reduced AT&T's workforce by 32,000 employees as he took a $3.2 billion write-off late last year to account for the job cuts and other consolidations within the corporation. The cuts will save AT&T $1 billion this year and $1.4 billion next year, according to Olson, who became chairman last September.

But the company is not cutting back in two important areas. According to Olson, AT&T will spend $3.9 billion on capital investment this year, up from $3.6 billion last year. And the company will also spend $2.4 billion on research and development this year, up 5.3% from last year. Said Olson: "As urgent as our financial objectives are, we are not after the quick, the cosmetic fix."

One of the major reasons for AT&T's recent losses has been an inability to succeed in the computer market place. The company, last year, reportedly lost $1.2 billion trying to compete against industry doyens IBM and Digital Equipment Corp. Olson, however, is not giving up. His new plan: leverage AT&T's phone expertise by selling computer and communication equipment as unified "data networking" systems. According to Vittorio Cassoni, a senior vice president in charge of AT&T's Data Systems Division, the company's computer business should turn a profit within the next two years.

continued...

ALPHABETICAL INDEX TO THE BILLION - DOLLAR CLUB

Company	Rank
Allied-Signal Inc.	9
AMP Inc.	40
Apple Computer Inc.	31
AT&T	2
Avnet Inc.	47
Boeing Co., The	33
Control Data Corp.	21
Data General Corp.	46
Digital Equipment Corp.	5
Du Pont de Nemours and Co., E.I.	37
Eastman Kodak Co.	17
Eaton Corp.	35
Emerson Electric Co.	45
E-Systems Inc.	51
Ford Motor Co.	26
General Electric Co.	3
GM Hughes Electronics Corp.	4
Grumman Corp.	30
GTE Corp.	32
Harris Corp.	29
Hewlett-Packard Co.	8
Honeywell Inc.	12
IBM Corp.	1
Intel Corp.	48
ITT Corp.	27
Litton Industries Inc.	23
Lockheed Corp.	10
Martin Marietta Corp.	28
McDonnell Douglas Corp.	38
Minnesota Mining & Manufacturing Co.	25
Motorola Inc.	11
NCR Corp.	14
National Semiconductor Corp.	39
North American Philips Corp.	18
Northrop Corp.	49
Perkin-Elmer Corp., The	50
Pitney Bowes Inc.	36
Raytheon Co.	15
Rockwell International Corp.	16
Singer Co., The	41
Tandy Corp.	19
Tektronix Inc.	44
Teledyne Inc.	43
Texas Instruments Inc.	13
TRW Inc.	20
Unisys Corp.	7
United Technologies Corp.	42
Wang Laboratories Inc.	22
Westinghouse Electric Corp.	24
Xerox Corp.	6
Zenith Electronics Corp.	34

General Electric

3 For an already diversified electronics company, 1986 proved to be a year of further diversification for General Electric. In June, the Fairfield, Conn., company acquired RCA Corp., which added network television, carpet and records to GE's already long list of businesses.

In its key technology businesses — aircraft engine, aerospace, plastics, medical systems and factory automation — earnings have grown 26% annually since 1981. In factory automation, last year GE formed a 50-50 joint venture with Fanuc of Japan, called GE Fanuc Automation Corp. GE and RCA's combined communications business equals nearly $2 billion in sales. In 1986, reports GE, 70% of the company's net earnings were in its technology and service businesses, compared with 50% five years ago.

Being diversified isn't always easy, however. While GE's technology businesses grow, the company is faced with continued slowdown in its power systems, motor, construction equipment and transportation systems businesses. But by 1991, reports GE, NBC, and its recent financial services acquisition, Kidder, Peabody & Company Inc., in addition to its major appliances and technology businesses, should account for 80% of net earnings.

GM Hughes

4 In its first full year of operations as a General Motors Corp. company, GM Hughes Electronics Corp. increased revenue nearly 10%, to $10.4 billion, and pushed earnings up 22%, to $594 million. Despite a slowdown in defense spending, sales at Hughes Aircraft Co., a division of GMHE, were up 11%, to $6.9 billion. And despite a 10% decline in GM auto production, sales at the company's Delco Electronics Corp., which sells automotive electronics, rose 6%, to $3.5 billion.

While speculations about GM's influence over its newly acquired Hughes division flew, last year was calmer for both the aircraft company and the auto maker than the previous year. On Dec. 31, 1985, GM bought Hughes Aircraft Co. for $5.2 billion, thereby forcing the ouster, from GM's board, of H. Ross Perot, who voted against the acquisition.

But the action may pick up again this year. Allen E. Puckett, chairman and chief executive at Hughes Aircraft, retired and was replaced by Albert D. Wheelon, former executive vice president at the aerospace concern. In other management shuffles, seven other veterans were promoted. Meanwhile, the outlook for both defense spending and automotive sales remains moderate. But GMHE will be one year older and its parent perhaps a little less patient.

DEC

5 Perhaps once every decade, a major IBM rival makes a serious challenge to IBM's industry dominance. In plumping itself up from roughly one-seventh to roughly one-fifth the size of IBM in the last two years, Digital Equipment Corp. has joined that elite.

Developing DEC Doomsday scenarios, of course, is becoming fashionable. New IBM product announcements, for example, are colorfully described as VAX killers. Unix, Japan's Trojan horse for penetrating the U.S. market, is also touted as a threat to proprietary operating systems like DEC's VMS. But the most common Doomsday scenario is that DEC will be squeezed between two new classes of supersystems: supermicros and minisupers. This recalls the off-target Doomsday scenario of the early 1980s which held that DEC's superminicomputers would be crunched between microcomputers and mainframes. DEC has enough time and more than enough resources to invalidate the new Doomsday scenario.

DEC will wait for the optimal moment to introduce VAX implementations competitive with both supermicros and minisupers. Two papers delivered at the International Solid State Conference early this year report a 2-micron VLSI chip set for parallel processing and a 135,000 transistor CMOS VAX microprocessor with onchip instruction and data cache. Precedent indicates these should be deliverable within a year. Although DEC will eventually be forced by its challengers into dramatic price/performance breakthroughs that will cut deeply into margins, DEC should have the technology reservoir to beat back challengers. The company, after all, has spent $2 billion on R&D in the last three years.

Xerox

6 Xerox Corp. is taking one last swipe at the office automation market by playing off its printed-word heritage and latching onto the electronic publishing fad. Xerox, of course, already has a huge presence in the office, and its copier business is holding strong in the face of Japanese competition.

Financial performance suffered last year, as Xerox shed the last of Shugart and Century Data Systems. The company also dumped some publishing units and bought a piece of systems integrator Federal Data Corp. to help out on government bids.

As usual, Xerox must figure out what to do with all of the wonderful technology that comes out of its Palo Alto, Calif., labs. This is the company that is credited with inventing the workstation and the Macintosh, yet capitalized on neither. It must manage its computer tangle — adopting DEC minis and reportedly switching PC suppliers, while getting its own workstation off the ground.

Unisys

7 For W. Michael Blumenthal, chairman and chief executive of Unisys Corp., his dream finally came true last year. Burroughs Corp. and Sperry Corp., two of the oldest hands at the computer industry, were merged into a $7.4 billion giant. By year-end, Blumenthal's merger had a new name, new management and new structure to give the combined companies a new, sleeker look.

Nearly $2 billion in assets, including portions of Burrough's Memorex subsidiary and Sperry's aerospace operations, were divested. Sales and marketing were consolidated and reorganized around vertical, target markets such as the financial services, manufacturing and airline industries. Product lines from both companies were upgraded and supported.

Now that the reorganization has been completed, ahead of schedule according to Blumenthal, 1987 will be the year Unisys has to prove itself. If Blumenthal's dream is to continue, Unisys, no longer two separate but equal companies, must learn to move as one. And become the powerhouse that Blumenthal envisioned.

continued...

Hewlett-Packard

8

Hewlett-Packard Co. is really two electronics companies: a $4 billion California computer company and a $2 billion Colorado instruments company. Both sides of the house have been looking to get its profit margin back to the 9% to 10% range.

In computers, the big news was the shipment of HP's first RISC architecture machine. HP is slowly but surely moving into reduced-instruction set computers across its business, manufacturing, and technical computer lines. The company faces a tricky double-balancing act in keeping its installed base of software operable on RISC and shifting to Unix in technical computing. A sign of success — HP emerged as a strong contender as the No. 1 workstation vendor, selling some $400 million worth of machines in that high-growth market.

In instruments, HP continued its dominance of a sluggish industry. Broaching the two businesses is HP's effort in CIM, for computer-integrated manufacturing. Even more than IBM, HP has the right to claim the most hooks to tie design, engineering, manufacturing and sales together in the company of the future. Whether customers really want that connection from one supplier is HP's big challenge.

Allied-Signal

9

Don't look for Allied-Signal Inc. in the top two dozen of next year's ELECTRONIC BUSINESS 200. Last year, the aerospace, automotive and materials conglomerate decided it could do better without the Electronics and Instrumentation sector that last year yielded 12% of its $11.8 billion sales.

So this spring, the corporation, with an apparent passion for sell-offs and acquisitions, began offloading audio unit Ampex Corp., connector maker Amphenol Corp. and others, in sales that will reap over $1 billion.

Allied-Signal is still rich in electronics — its Bendix unit is a talented aerospace player. But the spring sale cuts aerospace's contribution to total revenue from 52% for fiscal 1986 to 44% now. And it further postpones Allied's goal of being revered as a high-tech force, not just a collection of bits and pieces.

Lockheed

10

Lockheed Corp. had a good year in 1986, with sales increasing 8% over 1985 figures. The company does 87% of its business with the U.S. government and it is divided into four major areas: missiles, space and electronics systems; aeronautical systems; information systems; and marine systems.

The missiles, space and electronics systems area is primary for Lockheed, and was significantly augmented in 1986 by the acquisition of Sanders Associates, a manufacturer of electronic countermeasure devices, signal processors, automatic test equipment and advanced electronic components. Despite the slow or no-growth status of the federal budget, Lockheed expects the defense electronics market to continue to outpace the budget. Electronics represent 35% of defense procurement, rising to over 40% during the next 10 years. Thanks to Sanders, Lockheed is well positioned to leverage that growth.

Another fast growing area for Lockheed is its Information Systems divison, which grew 100% from 1985 to 1986, due in part to the acquisition of Sanders division, CalComp, a manufacturer of computer graphic terminals, plotters and digitizers.

One of Lockheed's biggest challenges in the future is retaining margins on its products. Problems with the C-5B aircraft program, coupled with public scrutiny into military contractors' "excesses" has made the company wary of retaining its technological edge under pricing pressure.

Motorola

11

Like other large semiconductor companies, Motorola Inc. struggled in 1986. But Motorola did manage a profit, posting pre-tax income of $265 million on $5.88 billion in revenue. Limited exposure to the memory business, along with substantial and successful diversification outside semiconductors, helped. Motorola also benefited from its broad product portfolio and market leadership positions in semiconductors. With everything from thyristors and zener diodes to 32-bit microprocessors and macrocell arrays chipping in, Motorola scratched out respectable semiconductor revenue growth of 9%. With the semiconductor business looking up, and with strong operations in mobile radio and cellular communications, Motorola is ready to roll. A bright first quarter saw pre-tax income rise by 29% compared with the first quarter 1986, while sales were up 10.5%.

Sales of communication equipment — which include two-way mobile radio systems — are leading the way. Orders for cellular radio gear are also sending out a clear signal, up 33% from a year ago. International sales, particularly in the Far East, have been another source of strength, growing 24% last year. Motorola's strong distribution network has been a key factor in booming Far East sales, according to Mona Eraiba, an analyst with Salomon Brothers Inc.

There are some weak spots. Motorola's computer systems business has been consistently in the red, says Edward C. White, analyst with E.F. Hutton. Earnings from government contracting have also been under pressure, according to White. But, with improved manufacturing efficiencies contributing to higher profitability in cellular radio, market leadership in 32-bit microprocessors, and broad strength in an improving semiconductor industry, Motorola should enjoy powerful momentum through 1987.

Honeywell

12

Honeywell Inc.'s revenue was $5.378 billion last year, up 7% from 1985.

Unfortunately for the balance sheet, Honeywell incurred major losses in 1986. Income from operations was down to $12.9 million, a drop of over 200%. The company suffered a major loss of $411 million from the disposal of Synertek Corp., which began in 1984, and the disposition of Honeywell's Information Systems (HIS) business, which will be completed in 1988.

Honeywell restructured in 1986, focusing on commercial aviation, military and space avionics, and ordnance and naval systems. The company has established a three-pronged approach toward restructure. Its business reorganized via cost cutting — Honeywell eliminated 3,200 jobs and several diversified ventures, including its Medical Electronics Division, Commercial Network Division, a commercial GaAs venture, Honeywell Ericsson

Development and Honeywell High-Tech Trading Co. Honeywell acquired Sperry Aerospace Group for a cool $1.029 billion to bulk up its presence in the commercial aviation market and to add to Honeywell's aerospace and military avionics business. It sold its Information Systems Group to Compagnie des Machines Bull of France and NEC Corp. of Japan, maintaining only a minority interest.

Texas Instruments

13 Last year was recovery year for Texas Instruments Inc. After losing $119 million in 1985, the company eked out a positive net income of $39.9 million on sales of $4.97 billion in 1986. But president and chief executive Jerry R. Junkins is not resting on his laurels just yet. In particular, he has two major long-term concerns: how to compete against the vertically integrated Far East corporations and how to smooth out the volatile, cyclical changes in the industry.

To answer both concerns, Junkins has a four-point plan: emphasize design automation and incorporate artificial intelligence (AI) into the technology; concentrate on manufacturing efficiency; target markets where TI can provide *system*-level solutions; and develop closer relationships with customers.

So far, Junkins' plan is working. For example, the company's new semiconductor fabrication facility built in Dallas has manufacturing yields comparable with the most skillful Japanese chip makers, according to Junkins. Better manufacturing prowess gives TI, with $1.9 billion in semiconductor sales last year, a chance at regaining the No. 1 spot in the industry after recently losing it to Japanese conglomerate NEC Corp.

Tighter customer relationships will also help. According to Junkins, TI has developed ship-to-stock programs with more than 50 leading electronic equipment companies. In addition to shutting out TI's competitors, these programs will also have a significant effect in moderating the volatility of TI's chip business. Such volatility has wreaked havoc with the company's finances in the past, such as in 1985 when TI's semiconductor sales fell 25% from the previous year.

NCR

14 NCR Corp. was proud that last year it moved away from the tradition of having the slowest growth in the computer business to a better-than-average 13% growth. The company is conservatively managed with an extremely sturdy balance sheet.

NCR is still holding true to its cash register origins. Point-of-sale and automatic teller machines are its strongest areas. The company brought out a new fault-tolerant host last year that kept compatible with its previous models, but it has not produced sales yet.

NCR is in the PC business, but has insulated itself from some of the volatility of that fickle market by selling into its customer bases in retail and finance. NCR's biggest challenges are its competitors. Tandem is hot, Stratus is teaming up with IBM, and the workstation companies are looking hungrily at NCR's markets.

Raytheon

15 Sales and net income in all Raytheon Co.'s divisions reached record levels in calendar 1986 and there is every expectation that the Lexington, Massachusetts-based company will not slow down in 1987. It is no secret that one of Raytheon's main strengths is its balance sheet. Net sales increased by 14% from $6.4 billion in 1985 to $7.3 billion in 1985, while net income rose by 4.6% from $375 million in 1986 to $393 million in 1986.

The electronics division, Raytheon's bread and butter, accounts for nearly 60% of sales, and defense electronics accounts for nearly 60% of all electronics. In all, over 53% of the company's sales are to the U.S. government. Even though defense spending has been capped, Raytheon's entrenched relationship with the DoD and the higher electronics content in all of the defense spending ensures the company will continue to profit from the federal government. Its main defense electronics products — the Patriot and Hawk missile systems — are highly profitable. This allows Raytheon a cushion as it gets more involved in the lower margin lines of second-sourcing defense contracts.

The other divisions of the company, including appliances, aviation, aerospace and energy services, also provide relatively stable sales growth for the company. One characteristic that differentiates Raytheon from its competition is its strong foreign defense business. Estimated at close to 17% of total sales, foreign-sourced revenue — including a $518 million extension to a Saudi Hawk contract — acts as a profitable insulation against potential domestic spending cuts.

Rockwell

16 Rockwell International, a respected player in the aerospace, electronics and automotive industries, has kept in stride for over a decade now. The $12.3 billion maker of the B-1B bomber and owner of industry automation specialist Allen-Bradley Co. posted its eleventh consecutive year of positive earnings growth in fiscal 1986, ended Sept. 30, 1986, with net income of $611 billion. But as the B-1 reaches the end of its production cycle next year and Congress puts a slowdown order on the space shuttle project, the uninterrupted growth may turn the company's stride to a slow walk by 1989.

To insure a smooth transition into the post-B-1 era, Rockwell is growing its $4.2 billion electronics business. Both telecommunications and avionics are prospering, but $1.07 billion Allen-Bradley — targeted for 20% annual growth by Rockwell back in 1985 — is looking pretty static as a result of cutbacks in corporate capital spending. The two other business segments, automotive and general industry, that together make up 20.5% of 1986 sales, are both healthy but do not offer the same kind of potential as electonics.

But, while some Rockwell watchers are forecasting a severe revenue drop-off by decade's end, a more optimistic contingent only sees a plateau or slight dip. The difference in opinion stems from how slow the slowdown in DoD business will be, whether the electronics recovery materializes, and if the national aerospace plane (NASP) ever gets off the ground. Nearly half of Rockwell's revenue is in aerospace and so the company's future is largely dependent upon the federal budget process. Without an explosive effort from AB, and electronics in general, Rockwell's hope of continued revenue growth looks unlikely.

continued...

Eastman Kodak

17

Eastman Kodak Co. spent 1986 trimming its sails. Nearly 13,000 employees left the company through a reduction in force program. Many manufacturing facilities and a variety of divisions were consolidated, all in an effort to improve its revenue-to-cost ratio. By the end of the year, net earnings — at $374 million on total sales of $11.55 — were up 13%.

During the same year of cost reductions, the Rochester, New York-based company also introduced more than 100 new and improved products. Heavy spending in both research and development — $1 billion — and capital expansion — $1.4 billion — resulted in a variety of product introductions including new copiers, a high-volume nonimpact printer that uses light-emitting diode technology, information management systems and write-once and erasable optical discs.

Sales of electronic products reached $3.85 billion during 1986, and represent one-third of the company's total revenue. During 1987, the company will be leveraging its expertise in photography to sell a number of electronic products. One of its new product lines includes computers that use optical disc technology for the storage and retrieval of large amounts of data and images.

N.A. Philips

18

With the dissolution of U.S. Philips Trust, NV Philips of Eindhoven, Netherlands, now directly holds 58% of North American Philips. Despite the fact that the remaining 42% of N.A. Philips is publicly traded on the New York Stock Exchange, many observers expect that this transfer will result in greater control of N.A. Philips by its Dutch majority shareholders.

Philips' managers face the task of turning around a troubled business in consumer electronics. Over the last three years, those operations have cost the firm a total of $23.7 million. The loss in 1986 was $6.4 million on sales of $1.3 billion. The color television business, which includes the brand names of Magnavox, Philco and Sylvania, continued to run at a loss, according to Robert Gutenstein, director of research for the securities firm of Kalb, Voorhis and Co. Costly picture-tube development programs contributed to the deficit. And the giant consumer electronic "superstore" retailers have also hurt consumer electronics manufacturers with their hardball purchasing tactics, according to Gutenstein. Firming prices in color televisions, the result of a currency-related profit squeeze on Japanese manufacturers, could help to put consumer electronics in the black in 1987.

Electronic components did much better, producing operating income of $136.5 million on revenue of $892.6 million. Although Philips is a leader in sales of passive components, it is not always recognized as the company behind its products. The parent logo is often obscured behind those of Airpax, Dialight, Mepco/Centralab and Ohmite. The situation is much the same in consumer electronics where Magnavox, Philco and Sylvania, not Philips, are recognized. To build brand-name recognition, the company is expected to begin marketing some audio products under the Philips logo. Meanwhile, the New York City-based conglomerate will have to make do with transcontinental ownership, multiple brand names, products as diverse as power resistors and electric shavers —- and a tidy $4.5 billion in revenue.

Tandy

19

Life at the low-end can be very lucrative. Just ask the folks down in Fort Worth, Texas, who have turned a pokey old cow town into the capital of personal computer (PC) clonedom. Tandy Corp.'s roots are in leather processing, but the only hides Tandy has been tanning of late are those of competitors in the home and small business PC markets. In 1986, Tandy passed AT&T, COMPAQ and Zenith to emerge as the leader in unit sales of IBM-compatible personal computers, according to International Data Corp. In the first quarter of 1987, sales of MS/DOS computers were up by a nifty 62% over 1986, according to the company.

Still, Tandy chairman John Roche knows that life at the low-end can also be treacherous. Taiwanese board makers, intent on earning their spurs in systems, are following the Koreans and the mail-order discounters into the PC clone bazaar. Meanwhile, the rate of growth in sales of the 7,000 U.S. Radio Shack outlets has slowed in recent months. No hot-box successor to video cassette recorders has yet been identified as consumer electronics' savior. And, even though Tandy has secured its flank with the acquisition of price-cutting superstore chains like Scott-McDuff and VideoConcepts, it is still vulnerable to powerful high-volume consumer electronics outlets in some areas of the country.

Although IBM's Personal System/2 should not hurt Tandy much in the small business and home-user sectors, Tandy's ambitious salesforce expansion to penetrate major business accounts will likely suffer. As IBM begins the arduous, but necessary, process of knitting together its personal computer and mainframe architectures, Tandy and other clones will find IBM's large corporate customers less responsive to sales pitches based on price.

TRW

20

Defense has been good to TRW. But a good chunk of the components business has not. Last year, TRW Inc. sold off its businesses in resistors, capacitors and transformers. It lost $100 million in sales but actually boosted profits from the sell-offs. TRW also bought four small service companies to boost its third-party service operations.

Meanwhile, the company is focusing on defense. Defense and space-related contracts are producing expertise in gallium arsenide, millimeter-wave and microwave communications, and the world's fastest digital signal processor. These and its VHSIC business could, if TRW plays its cards right, translate into a strong position in the commercial semiconductor world.

TRW is in good shape, even if defense spending shrinks, due to its electronics and satellite emphasis. SDI is also a no-lose situation with a potentially huge payoff.

Control Data

21

The good news has begun to trickle in. A first quarter profit, a debt rating upgrade, a break-even in peripherals, and a major disk drive contract from — of all people — Japan's Sony Corp. After a calamitous series of mishaps and world-class financial losses, Control Data Corp. is flirting with success.

But it is not yet clear that this romance will be consummated. CDC did narrow its losses in 1986: but that was from roughly half a billion to roughly a quarter billion dollars. And even though some analysts foresee profitability for 1987, the company's long-range strategic direction is not yet in view.

In selling off both unproductive and unrelated businesses, CDC has focused on core enterprises in computer systems, peripherals and computer services. Data storage products, the company asserts, were slightly profitable in 1986. This is no mean accomplishment since, in 1985, they spun their way to $300 million in losses. Posting a profit, while revenue declined from $1.27 billion to $1.05 billion required trimming product portfolios, closing facilities and eliminating more than 9,000 jobs. But improvements in manufacturing processes have produced more reliable drives, and some analysts believe CDC has actually regained market share on some of its larger Winchesters. Two other positives for the company have have been its steadfast funding of R&D and the emergence of third-party maintenance as a lucrative growth business.

But the soul of CDC has always been in its computer business. Revenue in this sector declined by 5.9% to $1.3 billion in 1986. Worse yet, it is hard to identify an area of exciting growth or market leadership in CDC's computer business. Its investment in next-generation supercomputers through ETA Systems is not expected to be profitable until 1989. If the company is to expand beyond its traditional strength in the electric utility industry, and in such applications as weather forecasting and petroleum exploration, it will have to demonstrate broader systems capability. One belated step in that direction was the recent introduction of a departmental processor. Much more will be necessary, and it won't come cheap. By raising $530 million from the spinning off of Commercial Credit Co. and by raising over $350 million through a public debt offering and yet another $140 million from asset sales, CDC has at least bought itself some time to rewrite its future.

Wang

22

Before struggling back to profit in its third period, that ended March 31, Wang Laboratories Inc., with its two quarters of losses, had been one of the computer sector's poorest performers.

The challenge for new president Frederick Wang is figuring out how to stay in the black. Although the company expects solid profitability for the fourth quarter, second quarter write-downs will make fiscal 1987 a red-ink year.

Fred Wang is shooting for better: by the early 1990s, he wants Wang to be a $5 billion company making 10% after-tax profit and growing the company's revenue in key markets 20% annually. A tough cost-cutting program and new 7000-series computers are a start. "We have the products and the people — now it's time to perform," says a spokesman.

Litton

23

Litton Industries Inc. is in a holding pattern. The company's sales declined from $4.6 billion in fiscal 1985, ending July 31, 1985, to $4.52 in fiscal 1986, and net income dove from $299.5 million in 1985 to $71 million in 1986. As a result of general economic conditions, the first half of fiscal 1987 looks equally sour with both sales and net income down. It appears that Litton's focus on the automation market's factory of the future is not materializing as quickly or as profitably as it had hoped. But with some restructuring, Litton intends to be a $1 billion automation player by 1990.

To turn things around, Litton recently acquired Lamb Technicon, a privately owned, Detroit-based engineering systems company that will open new markets in factory automation, especially with the big auto makers. Also, because of the drop in oil prices, Litton spun off its resources group — an oil exploration operation — by entering into a joint venture with Dresser Industries Inc. The new venture, of which Litton controls 70%, is called Western Atlas International and allows synergies that both companies hope will lead to profits. Litton's military business remains strong with backlogs into 1992.

The rebound of Litton's sales and income will depend primarily on the health of the U.S. economy, on oil prices and the move toward factory automation. But with Litton's commitment to be one of the top four factory automation companies in the market, the message is clear: Litton is in for the long haul.

Westinghouse

24

Last year, Westinghouse Electric Corp. was probably pressed to find enough pens to sign all of the military contracts it won. Its challenge now: deciding which of many new opportunities to pursue, and how to form the teams to pursue them.

Defense electronics — radar especially — remains Westinghouse's high-tech high point. Sales and profits grew as it won avionics development awards with both Advanced Tactical Fighter prime contractor teams and was chosen to supply the radar for Britain's Airborne Warning and Control System (AWACS) planes.

Backed by an award-winning automated factory in Texas, Westinghouse has produced over 2,000 radar packages for the F-16 fighter; new orders promise $600 million more. The outlook for Westinghouse's military-electronics sales, defense downturns notwithstanding: up to 10% annual growth.

3M

25

3M Co.'s Electronic and Information Technologies Sector is projecting modest sales growth in 1987. The Electro-Telecommunications Group hopes to outpace the growth of the markets it serves by focusing on rapidly expanding product, notably telecommunications test equipment and fiber-optic connectors. Last year, 3M acquired Dorran Photonics Inc., a New Jersey manufacturer of fiber-optic connectors used in the telephone and datacommunication industries.

The Memory Technologies Group, meanwhile, expects to reduce operating losses this year and further increase earnings in the future. "Investments in more efficient production equipment are resulting in substantial cost reductions and are helping to cushion the impact of continued price erosion," says Allan J. Huber, the sector's executive vice president. "Significant economies also are resulting from consolidation of video and data recording businesses into a single operating unit." This year, 3M will begin producing erasable optical media. Last year saw the start up of a new plant for prerecorded optical media.

The sector's Information Systems Group is optimistic about future growth in the face of the demand for improving productivity in the office. New electronic systems for document storage and retrieval were introduced last year. And Harris/3M Document Products Inc., a joint venture with Harris Corp. for copiers and facsimile machines, completes its first year of operation. In 1986, 3M's electronics revenue climbed to $2.46 billion from $2.272 billion the previous year.

Ford

26

Ford Motor Co. is optimistic that the trend toward increased electronics in automobiles will continue. The company's Electrical and Electronics Division (EED) is investing $94 million to make new-generation alternators and $78 million to make starters. At Ford Microelectronics Inc., large-scale integrated circuits are tested to guarantee top-quality engine-control devices.

In 1986, Ford Aerospace & Communications Corp., meanwhile, achieved contracts worth a record $1.7 billion, up 29% from the previous year. Ford Aerospace makes tactical weapons systems, advanced space systems and C^3I (command, control, communications and intelligence) systems. Eleven Ford Intelsat V satellites transmit two-thirds of all overseas communications, according to the company.

Last year, Ford's electronics revenue climbed to $2.423 billion from $2.071 billion in 1985. A primary concern at Ford is, of course, the lopsided balance of trade with Japan and increasing competition from South Korea and Taiwan. Ford sees cost cutting and productivity improvements as key challenges and is spending heavily to expand computer-aided design and manufacturing operations throughout the company.

ITT

27

ITT has been churning with change. Last December the company spun off its worldwide telecommunications equipment manufacturing operations into a joint venture with Compagnie Générale d'Electricité (CGS) of France. CGS is running the joint venture, named Alcatel N.V.; ITT retains just a minority 37% ownership.

So ITT, once a powerhouse in the market, has called it quits in telecommunications. Although the company still has a $1.7 billion stake in the industry, it is basically a passive investor. The joint venture with CGS follows ITT's much-publicized failure to develop a competitive digital telephone switch. After spending a reported $1 billion over 10 years, ITT produced the System 12, a product that U.S. customers shunned. In fact, the System 12 was so unpopular that last year ITT withdrew from the U.S. switching market altogether.

The company's telecommunications operations is one of the latest casualties in ITT's bid to divest itself of certain businesses. Since 1979, ITT has sold more than 100 of its companies and the employee ranks have correspondingly fallen from a staff of 369,000 to just a third of that last year. Chairman and chief executive Rand V. Araskog says that the leaner ITT will better be able to concentrate on more strategic businesses. (Through the joint venture with CGS, ITT received $1.3 billion from which the company knocked off $750 million of debt from its balance sheet.) More than half of ITT's 1986 revenue of $17.4 billion came from the company's insurance and financial services operations. Of the remainder, ITT's major businesses include automotive parts, defense and space products, electronic components and pumps, among other diversified products.

Many Wall Street analysts speculate that ITT is not yet done divesting. Up for sale soon, some say, could be the company's paper products business and Sheraton hotel chain.

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Martin Marietta

28

Facing increased competition and more restrictive government budgets, Martin Marietta Corp. is focusing its expansion on systems with high electronics content. It has, to a large extent, become a defense electronics supplier, with 40% of all 1986 defense sales derived from that source, according to the company. Such revenue has more than doubled in the past three years and will continue to climb over the next few years.

In 1986, Martin Marietta's electronics revenue rose to about $2.16 billion from $1.882 billion the previous year. "Our belief is that the growth of defense electronics will outpace the growth rate of the total defense market," say Thomas G. Pownall, chairman and chief executive, and Norman R. Augustine, president and chief operating officer, in the company's 1986 annual report. Martin Marietta is in the aerospace, defense electronics and information systems businesses, as well as energy and materials.

Martin Marietta hopes to avoid cyclical downturns by maintaining a diversified portfolio. Its 10 largest programs account for about half of total sales. The largest is less than 10% of total sales. With this in mind, the outlook for 1987 and beyond in positive, although growth will vary from industry to industry. The information systems business, for example, is expected to expand rapidly. With cutbacks in Defense Department and NASA budgets, however, aerospace growth will slow. Nonetheless, although the grounding of the Space Shuttle has resulted in order delays, it — along with new government space policies — has also expanded the market for expendable launch vehicles. The Air Force, for example, has increased orders for the Titan family of launch vehicles. And Martin Marietta also is offering a commercial version of the Titan to take advantage of the backlog of communications satellites needing transportation into space.

continued...

Harris

29 To combat sluggish demand in Harris Corp.'s three key markets — information systems, communications and semiconductors — president John Hartley last year went back to basics with a streamlining plan that smartens up manufacturing, boosts quality and weeds out slack product lines such as cellular phones and programmable read-only memory chips.

He must be doing something right. Earnings for fiscal 1987's first three quarters are headed north: up 24%, 38% and 43% respectively on 1986. The third quarter showed sales gains and returns to profit in information systems and semiconductors.

But Hartley is far from ecstatic. Lacking firm market upswing, Harris needs more marketing polish and name recognition in commercial markets so sales and profit gains won't lose momentum.

Grumman

30 Grumman Corp.'s revenue for fiscal year 1986 was $3.502 billion, up 12% from 1985, although net income of $78.7 million was down 3% from 1985 figures. And its 1986 electronics sales, which made up 14% of Grumman's overall sales, doubled to $2.075 billion from 1985's $1.128 billion.

The company opened a new plant in Salisbury, Md., for electronics systems manufacturing and began work on a plant in Benton, Pa. The company was the third largest recipient of the Department of Defense's prime contractors for research, development, test and evaluation awards for fiscal year 1986, receiving $910 million; and it was the 10th largest recipient of overall contract awards from the Department of Defense, drawing in $2.967 billion.

Grumman's reaction to increased congessional pressure to tighten up procurement expenditure is evident in its efforts to cut costs. The company relocated nonmilitary space operations from Long Island, N.Y., to Houston, and opened a Joint STARS (Surveillance Target Attack Radar System) facility in Melbourne, Fla., citing lower cost of living rates and better competitive pricing margins for engineering talent as reasons for the move. Grumman also spent $191 million on capital equipment in 1986 in order to modernize facilities as a result of increased governmental pressures to upgrade manufacturing facilities and decrease fiscal waste.

Apple

31 After a tumultuous year in 1985, when Apple Computer Inc. jettisoned the last of its founding fathers, the company concentrated on controlling costs, with annual sales remaining in the $2 billion range.

Although the company began the year by introducing the Macintosh Plus — which gave Apple its first real inroad into the Fortune 2000 market — and followed with the Apple IIgs in September, the company's most important efforts might have been in positioning itself for a transformation toward higher-end systems in 1987.

Under a new division responsible for the company's strategic development, Apple purchased hardware developer and Unix systems house Cadmus in the summer of 1986 and created a venture capital fund. Those strategic decisions paid off in early 1987, when the company introduced the OpenMac, a Macintosh with six slots and a dedicated Unix microprocessor option designed to leverage Apple into the value-added reseller market. The company also made its first investment in a software developer, Forethought Inc.

GTE

32 Telecommunications titan GTE Corp. will be happier when it stops losing money on the U.S. Sprint long-distance network it owns half of. Otherwise, it has few complaints about 1986, a year of record sales and net income.

Communications products — GTE's main electronics unit — showed higher income as margins improved on consumer items such as telephones. Government systems are enjoying steady revenue increases, thanks largely to a whopping $4.3 billion Army battlefield-communications award.

Now, 1987 will show whether GTE can sell its GTD-5 digital switch to those most discerning customers: the Bell operating companies. And it will prove whether GTE was right to form recent joint ventures with Siemens AG on its international transmission systems and public-switching operations, and with Fujitsu America Inc. on business-communications systems for U.S. markets.

Boeing

33 The Boeing Co. anticipates reduced sales in 1987 and continued pressures on profit margins in both commercial and government programs. In 1986, electronics revenue increased to $1.975 billion from $1.85 billion the previous year. Government budgetary constraints and procurement policy changes will mean fewer new program starts, increased competition and tougher accounting practices.

Still, Boeing is optimistic that it can offset these pressures by cutting costs and improving productivity. Strategic alliances, for example, will help reduce the cost of expensive computing and electronics programs. An agreement with Honeywell calls for that firm to supply Boeing access to very high speed integrated circuit technology for specialized applications. And Boeing agreed to market and supply operating software for Scientific Computer Systems' SCS-40 near-supercomputer.

In 1986, Boeing received a number of plum contracts. After intense competition, the Boeing E-3 AWACS was chosen as Britain's airborne early warning system, extending the life of this program. Boeing was awarded full-scale development funding for the V-22 tilt-rotor aircraft, Sea Lance missile, Hard Mobile Launcher and Short Range Attack Missile II. It also gained a key role on one of two teams selected to develop prototypes of the Advanced Tactical Fighter. "1986 was a rewarding year for the company, and the long-term outlook is positive," says T.A. Wilson, chairman.

continued...

Zenith

34 Last year, Zenith Electronic Corp.'s sales bounced back up, to $1.89 billion, after slumping in 1985. Still, the company faced its second straight yearly loss, amounting to $20 million before taxes. Those who live by the VCR, die by it. Higher volume sales were offset by shrinking prices, and Korean and Taiwanese television pricing — Zenith calls it "dumping" — hurt as well.

To combat consumer pricing, Zenith switched over to a new, surface-mount technology chassis for its color TVs. That hurt margins last year, but should cut costs in 1987. Likewise, a new line of flat tension-mask picture tubes and monitors, with $20 million in capital behind it, will start showing up in Zenith computers this year and in TV sets in 1988.

Computer sales were up 56%, to $548 million, and Zenith won two choice government contracts. The much-publicized IRS lap-top computer deal should be worth $27 million, but a three-year, $242 million military contract will initially be a low-margin exercise.

Eaton

35 During 1986, Eaton Corp. played to its strengths. The company, founded in 1911 as a manufacturer of truck axles, had diversified into a number of areas over the years, some of which had ceased to be profitable. So last year the company retrenched, focusing its energies on its major business areas: the controls operations market, including automotive and electrical controls and equipment; the defense industry; and the automotive and truck power train market.

As a result, the company plans to sell its Eaton-Kenway division, which serves the automated materials handling market, and the Industrial Polymer division. Eaton has also exited the microwave test market and liquidated several product lines in its semiconductor equipment operations.

Supporting its new strategy, Eaton acquired the Singer Company's controls division in June 1986 (sales in 1985 were $106 million), which produces electronic and electromechanical control devices primarily for automotive and appliance manufacturers. Also acquired last year was Consolidated Controls Corp. from Farley Industries, which had $106 million in sales in 1986. Consolidated Controls manufactures switches, actuators and power control systems for the aerospace/defense industries. Eaton also purchased American Nucleonics Corp., a manufacturer of advanced microwave systems and antennae.

Known in the financial community for astute financial leadership, Eaton is in the enviable position of having 73% of its products be in either the No. 1 or No. 2 spot in market share during 1986.

Pitney Bowes

36 As the worldwide leader in postage meters, and mailing and shipping systems, Pitney Bowes Inc. of Stamford, Conn., enjoyed another prosperous year of steady growth in 1986. Its revenue of $1.99 billion was up 9% over 1985, reflecting a higher increase than any in recent years. Meanwhile, net income grew by 17% to $166 million.

Chairman and president George B. Harvey expects growth this year will be even stronger. According to him, Pitney Bowes sales will grow at least as fast as they did last year. He explains that his company introduced more than 50 new products last year and those products will, this year, have the benefit of a full 12-month revenue flow. Also, Pitney Bowes is introducing another high level of new products in 1987.

While the company has maintained its leadership in mailing and shipping systems, which accounts for more than half of total revenue, it has also begun to prosper in other markets as well. In particular, sales of Pitney Bowes facsimile machines grew by 77% last year. The company claims a leading position in Great Britain and West Germany and says it is the No. 1 supplier of new facsimile units in Canada. In addition, Pitney Bowes is also prospering in the Dictaphone and voice-processing system market. This sector's 1986 revenue of $235 million was up 15% over 1985. And furthermore, the company's financial services group logged a 16% increase in net income last year. This group claims a portfolio with 1986 year-end gross financial assets of $2.2 billion, up 27% from 1985.

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Du Pont

37 For a chemical company, $1.7 billion in electronics sales isn't bad. But E. I. du Pont de Nemours & Co. is looking for more than that. After creating a new Electronics Department in October last year, the company hopes to up its electronics sales and reach $2.5 billion by early next decade.

To do that, the Wilmington, Del., company plans to invest $135 million this year in electronics research and development and forge, through acquisitions and joint ventures, into new markets. Primarily a maker of electronics materials and connectors, Du Pont is aggressively moving into optoelectronics and information storage. Last year alone the company entered into an optical-disc technology joint venture with N.V. Philips and acquired three firms, including Tau Laboratories Inc., a maker of photomask products for the semiconductor industry.

Du Pont's challenge this year is to manage all of these activities, particularly in new markets where the company faces formidable, more seasoned competitors.

McDonnell Douglas

38 McDonnell Douglas Corp. last year had $12.6 billion in total revenue. But things may get tougher for this major defense contractor whose electronics-only revenue for 1986 totaled $1.7 billion. U.S. government procurement practices are going through some changes that will increase competition among government contractors and will press even harder on corporate bottom lines.

As if anticipating these times, McDonnell Douglas several years ago ventured into the communications business with dreams of generating a high level of earnings based on multibillion-dollar revenue. Instead, the Information Systems Group (ISG) has continued to rack up losses for four consecutive years, including a $69.7 million loss based on 1986 revenue of $1.19 billion. The challenge for ISG in 1987 will be to break even.

Across the board, McDonnell Douglas is faced with the task of improving productivity in order to increase profits. The company also hopes to win an increasing number of government contracts.

National Semiconductor

39 The good news regarding National Semiconductor Corp.'s 1986 financial performance is that revenue was up 4.5% to $1.678 billion. The bad news is that losses — which totaled $57 million — continued to plague the bottom line.

While struggling with the residual effects of a dramatic industry downturn, National upped its allotted research and development expenditures to approximately 15% of total revenue. This spending was focused on the development of high-density CMOS, MOS and VLSI technologies and products, as well as on point-of-sale terminals and systems.

National is looking to both internal and external forces to improve its performance in 1987. In addition to shipping a number of new products this year, the Santa Clara, California-headquartered company is changing some marketing strategies including expanding its distribution base and creating a direct sales group in the United States for its Semiconductor Group. At the same time, the overall business climate is gradually improving, which should have a positive effect on 1987 financial results.

AMP

40 Last year the world's No. 1 connector maker, AMP Inc., was recovering from a sluggish 1985 during which sales declined 10%. Throughout 1986 the Harrisburg, Pennsylvania-based manufacturer had to walk a fine line — cutting costs and boosting profitability, while preserving its technology, sales and manufacturing bases in order to be prepared for the inevitable industry upturn.

The numbers indicate that AMP — whose total 1986 revenue rose to $1.9 billion — is emerging generally unscathed. Earnings have inched up to 8.5% of sales and last year's electronics revenue of $1.6 billion represented an increase of 18%. Today, analysts estimate that the company's U.S. plants are running at roughly 70% capacity, which leaves AMP with the continued challenge of increasing capacity and containing costs.

The 1987 game plan calls for more streamlining of U.S. operations, while expanding international sales and manufacturing bases in the Far East, Europe and South America. In addition, AMP is looking to broaden its product offerings. One new market focus is networking and customer premises wiring. And, last year's acquisitions of Fiber Optics Communication Specialists (FOCS) and Lytel Inc. will enhance AMP's interests in electro-optics.

Singer

41 In 1986 The Singer Company completed its six-year business plan of shedding its slow-growth commercial operations and repositioning itself as an aerospace/electronics firm. Consequently, the company that has a name synonymous with sewing machines spun off that operation as well as its furniture business.

In addition, the Stamford, Connecticut-based company — which generated $1.48 billion in electronics revenue last year — sold its Controls Division in order to fund two strategically important acquisitions. The Dalmo Victor Division of Textron Inc., a manufacturer of radar warning systems, cost Singer $174 million. No price was disclosed for the purchase of privately held Allen Corporation of America, a developer of defense-related training programs and related equipment.

Now that the corporate reorganization is complete, Singer is free to concentrate on the further development of existing lines of business with particular attention being paid to its government products, which accounted for $1.43 billion, or 83% of last year's total revenue.

United Technologies

42 On the heels of a major restructuring, United Technologies Corp. is projecting growth this year in its core electronics-related businesses — aerospace, defense and automotive. In 1986, United Technologies electronics revenue fell to $1.413 billion from $1.877 billion the previous year. "The disappointing results for 1986 confirmed the necessity of the restructuring actions we have taken and left us more confident than ever of the basic strengths and future prospects of United Technologies," says Robert Daniell, chairman and chief executive.

As part of its housecleaning of the past two years, United Technologies has disposed of its Mostek semiconductor business and sold its telecommunications operations. Companywide, in 1986, strong earnings performance at Pratt & Whitney (engines) and UT Automotive and Carrier (building group) somewhat offset the effects of operating difficulties at Hamilton Standard (controls) and Norden Systems (radar).

United Technologies' optimism is based at least in part on groundwork laid in 1986. Norden reorganized its advanced radar programs following a $155 million write-off due to anticipated losses on contracts in this area. Hamilton Standard won seven development contracts relating to the space station. United Technologies Microelectronics Center (UTMC) was certified by the Defense Electronics Supply Center, improving its competitive position in aerospace and military markets. And Sikorsky rolled out its new X-Wing Rotor Systems Research Aircraft which takes off and lands vertically.

Teledyne

43 At Teledyne Inc., sales were up last year, but operating results were down. Management blames the decrease in Teledyne's $1.4 billion Aviation and Electronics segment on higher expenses and lower margins in government R&D contracts. Teledyne's industrial sector electronics suffered as Big Oil stopped buying.

Thirty percent of Teledyne's myriad businesses depend on the government, and much of that is defense oriented. Thus, the continuing stagnation of the defense budget worries Teledyne, even as the electronics content of weapons goes up.

Tektronix

44

Tektronix Inc.'s 1986 sales were down in instruments, communications and graphics. So far this year, however, things are looking up. Sales are up slightly, and profits are up 60% for the first nine months.

A couple of years ago, under intense pressure from Japan, Tek set out to make itself a world-class manufacturer. Now the company is a leader in just-in-time, and other manufacturing and inventory techniques, resulting in seven inventory turns per year.

Tek must establish itself in the computer-aided engineering business, or risk losing hold of its instrument customers. Its 2-year-old, $75 million acquisition of CAE Systems has yet to yield big results, however. But a new line of graphics terminals and oscilloscopes show that Tek can still match or better the competition in its core businesses.

Emerson Electric

45

Emerson Electric Co. has built a reputation for itself as a broad-range supplier of electronic products. Today, however, the $5 billion company is being squeezed by an onslaught of foreign competition. During 1986, imports rose 14% in the markets where Emerson competes.

Although some economists predict that the import intrusion will level off in 1987, Emerson is not counting on it. Instead, the St. Louis, Missouri-based company will continue its plans of consolidating U.S. manufacturing operations, while expanding both product lines and international markets.

Also included in Emerson's expansion plans is a desire to increase its interest in electronics, which last year accounted for $1.3 billion or 25% of total revenue. The company's most recent acquisitions in this area include Copeland Corp., purchased for $541 million; Hazeltine Corp., purchased for approximately $189 million; and Liebert Corp., purchased for roughly $516 million.

Data General

46

Although revenue was up in 1986, net income was down, way down: Data General Corp. had a net loss of $28.9 million in 1986. The company suffered an extraordinary loss of $34.7 million, which resulted from the settlement of litigation between Data General and Fairchild Semiconductor Corp. and the after-tax charge from the early redemption of the company's $75 million 13% Sinking Fund Debenture, due in 2005. Data General's income from opera-

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tions is only $20.7 million, down 42% from 1985 and down nearly 500% from 1984.

In efforts to realign itself to remain competitive in the marketplace, Data General has restructured its corporate organization into two areas. The Information Systems Group focuses on high-growth market segments; the Communications Systems Group focuses on networking, datacommunications products and future services. The company discontinued volume manufacturing of semiconductors at their Sunnyvale, Calif., plant because small-volume manufacture at the facility was noncompetitive. Facilities were also closed in Austin, Texas, and Hong Kong. The company has shifted its personnel from administration and manufacturing to sales, systems engineering and product development. Even with these changes, Data General was forced to cut its staff from 16,535 to 15,565 employees, a reduction of 970 people.

Since Data General established its Communications Systems Group, the firm has purchased several ventures in efforts to break into the datacommunications and network markets. DG acquired an integrated digital network operation from United Telecommunications Corp.

Avnet

47

As the top-ranked industrial distributor in the world, Avnet Inc. is in a league of its own. But just because it is twice the size of its nearest competitor, Avnet is not immune to the protracted electronics industry downturn. The New York City-based company's sales have been slipping for the last three years, from a record 1.6 billion in fiscal 1984, ending June 30, 1984, to $1.4 billion in fiscal year 1986. Avnet's earnings have also declined from $86.8 million in 1984 to $23.9 in 1986. And sales for the first six months of fiscal 1987 were up, as net income continues its decline.

This deteriorating financial position is partly the result of overproduction, overstocking and a continuing dismal demand for electronic components, particularly semiconductors. But Avnet is fighting back with entry into new markets and some internal structural change: these include application-specific integrated circuit (ASIC) design centers; more of a focus on computer systems; strategic alliances with a number of companies; a restructuring of the company's branch network; and a commodity franchise between Time Electronics, a member of Avnet's Electronic Marketing Group, and Motorola Inc.

Avnet's recovery is inextricably tied to the electronics industry recovery. Signs are appearing, indicating that business is on the mend: book-to-bill ratios are improving, inventories are being whittled down, and prices are firming. There is little chance that growth rates of the magnitude experienced in 1983 and 1984 will happen again soon, but Avnet will continue to dominate distribution.

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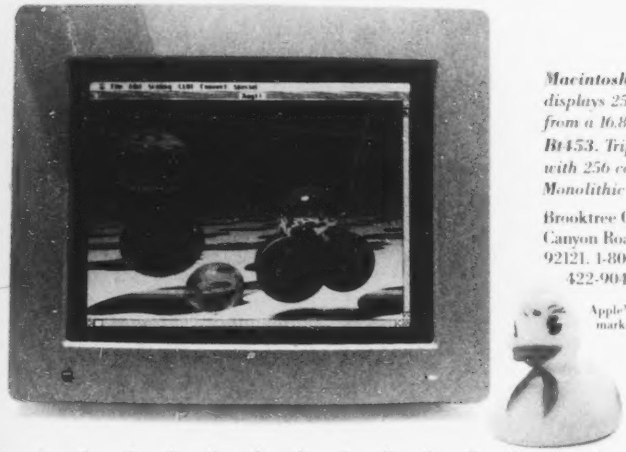

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Intel

48

In Intel Corp.'s 1986 annual report, chairman Gordon E. Moore and chief executive Andrew S. Grove began the document with a terse statement: "We're pleased to report 1986 is over." Indeed, since 1985 when the current semiconductor recession began, Intel has closed eight of its plants, reduced its workforce by 7,200 employees and lost more than $170 million.

But things have been picking up recently at the Santa Clara, California-based semiconductor manufacturer. After operating income losses of $195 million last year and $60 million in 1985, the company now appears ready to breeze back into the black. For the first quarter of this year, Intel reported a net income of $25.5 million on sales of $395 million.

The company said the good news was due, in part, to an increase in demand by customers in the personal computer industry. In fact, the company has said that it might sell as many as 4 million of its 80286 microprocessors this year, about double the approximately 2 million the company sold in 1986. The 80286 is used as the brains of many personal computers, the IBM PC AT chief among them.

Furthermore, Intel is counting on strong sales of its new 80386 chip, successor to the 80286. The company predicts it might sell as many as 1 million 80386 chips this year. Intel's boasts are not without substance. IBM announced last spring that it would use the 80386 in the next generation of Big Blue personal computers. But the sailing has not been all smooth for Intel. A recently discovered obscure malfunction in the 80386 has forced the company to recall some of the chips. The company took a special charge against earnings in the first quarter this year in anticipation of replacing the defective chips.

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Northrop

49

Northrop Corp. had revenue of $5.608 billion in 1986, up from 1985 revenue of $5.056 billion. Net income dropped sharply from the year earlier, coming in at $41.2 million for 1986; 1985 net income was $214.4 million. Electronics sales, which are 22% of total revenue, were $1.248 billion for 1986.

The company ranked 31st overall for the top 100 companies and subsidiaries according to net value of prime contract awards for the U.S. Department of Defense, with $742 million awarded in 1986, and also 31st in DoD prime contract awards for research, development, test and evaluation, totaling $160 million.

Research and development spending increased to $70 million, up from 1985's $30 million, as a reaction to governmental reductions in defense contractors' profit margins and transferal to private industry of some financial responsibility for new weapon development. Northrop claims that the increased spending in R&D cut sharply into earnings for 1986, noting that R&D programs usually produce lower margins than those in production. Northrop also says that classified programs are growing in number, scope and as a proportion of Northrop's total business.

Perkin-Elmer

50 A combination of diversified product groups and an adherence to strict cost controls helped to keep $1.3 billion Perkin-Elmer Corp. profitable in a year when many of its major markets were sluggish at best. Indeed, the company's 1986 electronics sales, the majority of Perkin-Elmer's revenue, only fell 3% to $1.18 billion.

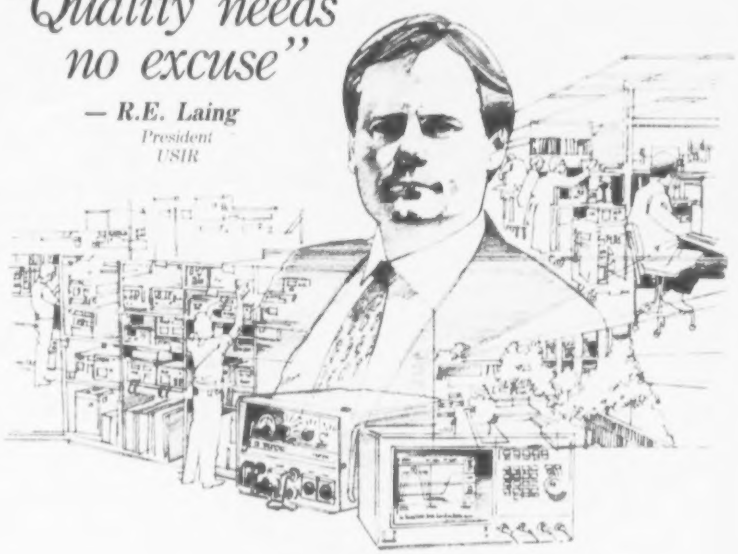
During a semiconductor industry downturn that stopped many companies dead in their tracks, Perkin-Elmer's Semiconductor Equipment Group managed to stay profitable despite suffering a 26% decline in sales during its 1986 fiscal year, which ended July 31. New products and a joint venture with Citizen Watch Co. of Japan are expected to keep this group afloat despite continuing adverse market conditions.

However, within the intensely competitive superminicomputer market, the company's Concurrent Computer Corp. spin-off needs to put the brakes on declining revenue. And for the Optical Group, the firm would like to attract more government contracts, particularly in the areas of defense and space. The company's joint venture with the Cetus Corp. is also expected to enhance the Instrument Group's performance, especially in the biotechnology market.

E-Systems

51 In 1986, Dallas-based E-Systems Inc. became a member of the billion dollar club by posting sales for the calendar year of $1.145 billion, up from $926 million in 1985. But the 15-year-old electronic warfare and defense communications company is not ready to stop at its first billion. If John Dixon, chairman and recently retired chief executive of E-Systems, gets his way, E-Systems will reach $2 billion by 1990. Company watchers are confident that he can be held to his word and are optimistic that the new chief executive, David Tacke, is a capable successor.

By pursuing a strategy of "focused expansion," as Dixon calls it, the financially sound company is looking to move into new markets and to become a prime systems integrator. To this end, the company is looking to establish joint ventures and acquisitions and to become more involved in the highly competitive international defense electronics arena through affiliations with foreign companies. E-Systems management is also aware that to reach $2 billion by 1990, it must optimize its resources and take advantages of economies of scale. Through organizational restructuring, management is addressing the efficiency issue. ☐



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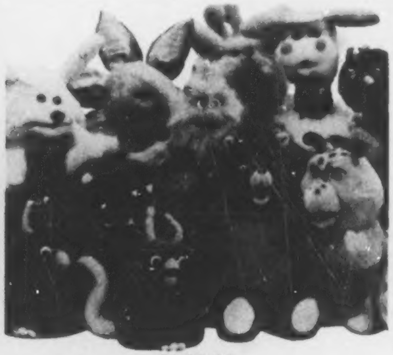
FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES



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Cover illustration: Scot Gordley

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BPA ABP

Are IBM's big orders a blessing or a curse?

Wyle sees growth in computer equipment. But Jaco blames them for longer leadtimes

For the first quarter of this year, the National Electronic Distributors Association reports that distribution shipments increased 8% with respect to the same quarter a year earlier. By contrast, Avnet's Electronic Marketing Group reported a 5% increase for the same period. Avnet's EMG consists mainly of No. 1 distributor Hamilton/Avnet and sixth-ranked Time Electronics, and accounts for one-sixth of total distribution sales. A larger portion of the increase in sales came from smaller distributors. Is this because it pays to specialize or that Avnet's sales, now less than 8% away from their peak in 1984, have held up during the difficult past two years better than any other distributor's?

The answer to both is yes. The largest among specialists is ninth-ranked Wyle Laboratories' Electronics Marketing Group, which does most of its business in large-scale ICs and in computer equipment. Wyle grew by 8.6% in the quarter that ended April 30, a little better than NEDA's sample of distributors. However, its business had dropped by 29% in the first year of the recession, and it is still more than 10% away from its previous peak of $275 million registered in the fiscal year ended January 1985.

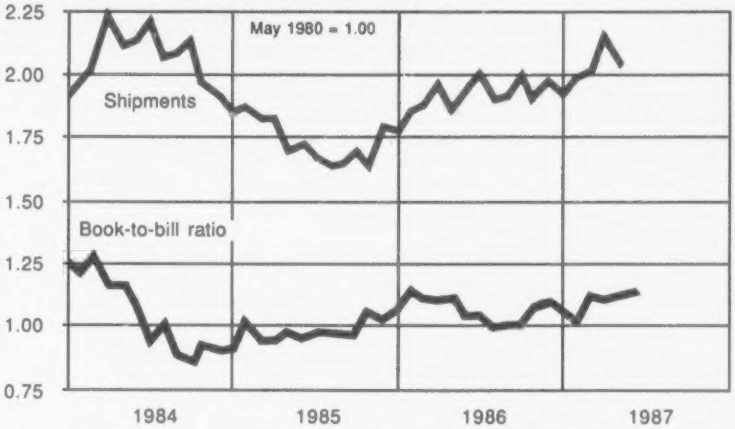
Jaco Electronics Inc., a capacitor specialist which, like Wyle, participates in the sample of industrial distributors that NEDA uses to report sales data, happily points to a 41% increase to $10.5 million in the first quarter. Jaco's president Joel H. Girsky reports a slighly higher level for the second quarter, but tempers this statement by saying that Jaco's sales peaked at $60 million in 1982 and were cut in half the following year. Sales have held roughly until they started growing this year.

This should make Girsky happy, but it doesn't. "I find it disturbing that last year the four top distributors lost money," he says, and claims some knowledge in the bottom line department: "We lost a lot in 1983." The main reason for the loss was inventories out of proportion with sales volume, he explains. Moreover, Girsky worries about the lengthening of leadtimes, an indicator that normally warms up the heart of distributors because it portends sales growth and higher prices. He attributes many component shortages to Big Blue. "IBM is placing a lot of orders," he says.

The impact of some of IBM's orders can be seen in Hamilton/Avnet's leadtimes. The top distributor has on allocation Intel Corp.'s microprocessors and large EPROMs, two very popular types of ICs not only for IBM but also among competitors, that make PC-compatible personal computers. But this does not bother Wyle Labs' president Charles M. Clough. He sees, from Wyle's vantage point as a specialist, many new systems entering the market based on Intel's 80386 32-bit microprocessor, and Clough even sees 10% to 15% growth next year for mainframes.

ALBERTO SOCOLOVSKY

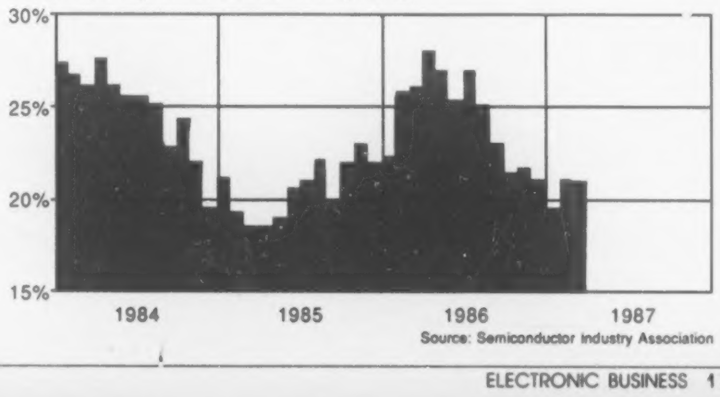
Distribution business index



Source: National Electronic Distributors Association

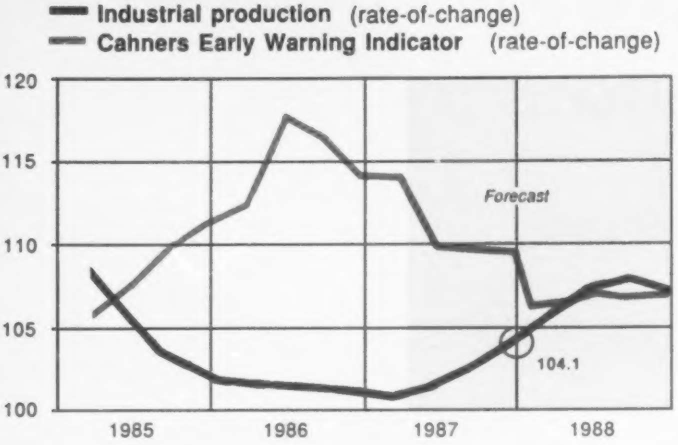
Distributors' share of IC shipments

(Percentage of U.S./Canadian shipments)

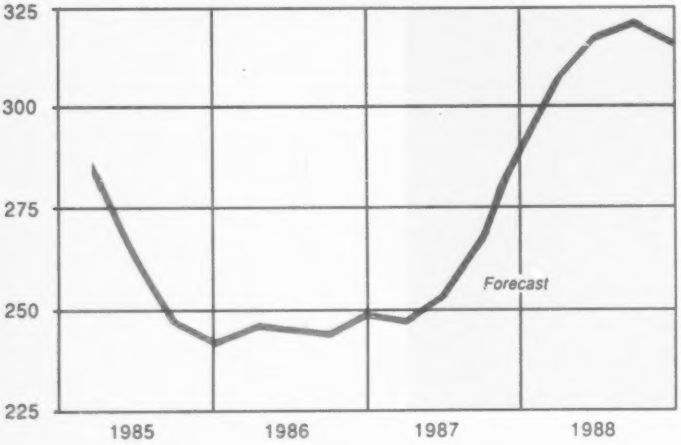


Source: Semiconductor Industry Association

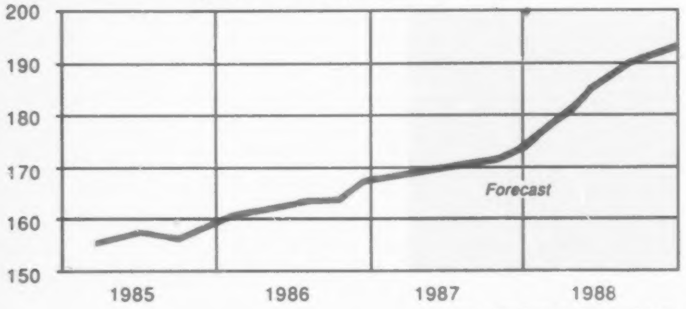
Economic indicators



Industrial production: Electronic components
(1977 = 100, quarterly averages)



Industrial production: Equipment, instruments and parts
(1977 = 100, quarterly averages)



Historical data: Federal Reserve Board
Forecast: Cahners Economics

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, has been climbing steadily since the summer of 1986. The fourth quarter was up 0.7% from the prior quarter bringing yearly production up 1%. This year, modest gains are expected to continue through midyear (first quarter production rose by 0.6%) with sharper increases in industrial production expected in the third and fourth quarters.

The Cahners Early Warning Indicator (CEWI) is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index. It forecasts probable business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 104.1 level forecasts using the CEWI for the end of this year indicates that the average for all of 1987 should be 4.1% above 1986.

Readers can obtain a brochure explaining the CEWI method from Cheryl Patstone, editor of the "Electronic Business Forecast" newsletter, Cahners Economics Department, 3031 Tisch Way, Suite 100, San Jose, Calif. 95128.

Electronic components

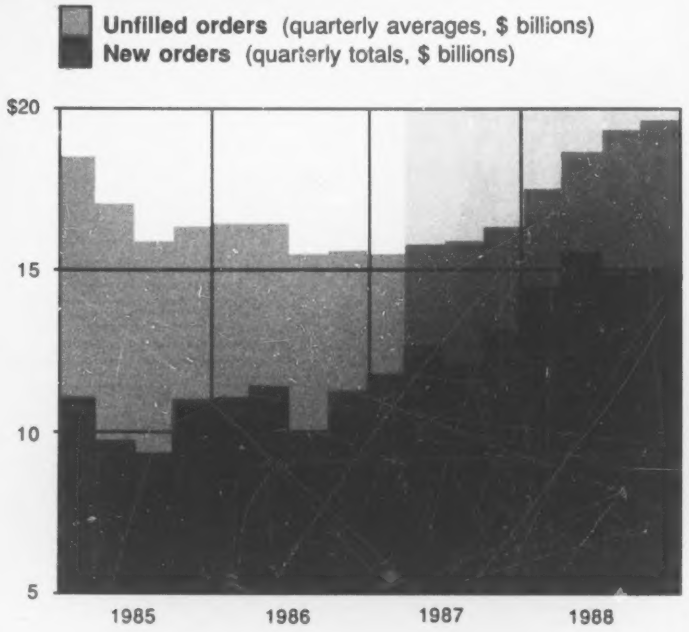
Component production, which had risen more than 2% in last year's fourth quarter, showed a slight decrease of 0.5% in the first quarter of 1987. But even as output was slackening, orders from computer makers and other major component end users were pushing ahead at an unexpectedly strong pace. This suggests that component production will experience more rapid growth as the current year progresses. By the end of 1987, output should be running nearly 20% ahead of the level at the start of the year, and this brisk uptrend will produce an overall annual growth rate of 7.9% over 1986. The industry is expected to remain on an upbeat next year, with growth accelerating to 19.6%.

Equipment, instruments and parts

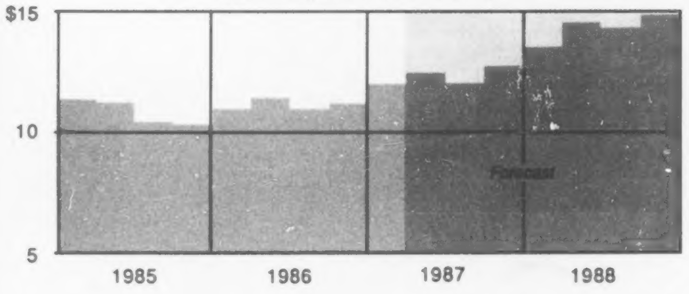
Instrument production shot up 2.8% in last year's fourth quarter, when U.S. businesses were accelerating their purchases to beat the 1987 tax law changes. Because this impetus was absent in the early months of this year, the overall pace of market growth cooled. First quarter production inched ahead just 0.7%, and early reports for the second quarter have pointed to a similar rate of increase. Gains are likely to remain slow-paced through summer, but a revival in capital spending should cause the recovery's tempo to quicken late in the year. Production is expected to post a modest 4.9% gain for 1987.

Electronic components

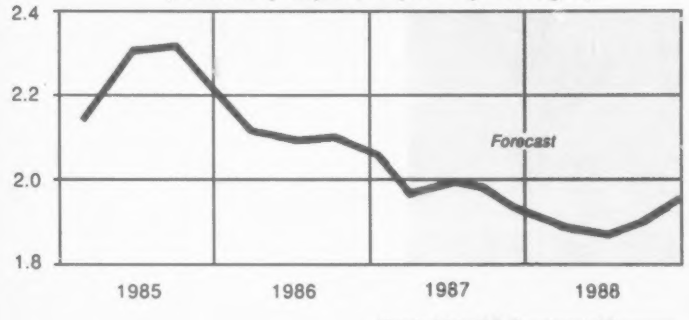
(SIC 367)



Electronic components: Shipments
(quarterly totals, $ billions)



Electronic components: Inventory-to-shipment ratio
(seasonally adjusted, quarterly averages)



Historical data: U.S. Department of Commerce
Forecast: Cahners Economics

New orders

Component manufacturers received $11.7 billion in new orders in the first quarter, up 5.2% from the prior quarter. This was the highest volume of orders since 1984's third quarter and was nearly $2 billion above last summer's figure. While part of the advance in early 1987 was caused by inventory replenishment, this was overwhelmed by the effect of stepped-up production for small computer systems and other types of electronic end equipment. These production gains are expected to keep the component market on a course of gradual recovery through most of 1988. Orders in 1987 are forecast to increase 14.5%. Next year, a 21.3% gain is expected.

Unfilled orders

Component manufacturers' order backlogs amounted to $15.52 billion at the end of the first quarter, down from the $15.63 billion in the prior quarter. This brought backlogs close to last summer's cyclically low level. The outlook for the remainder of the year is more favorable. Early second-quarter reports suggest that the volume of unfilled orders will begin to push upward, showing a gain of $300 million. This trend will be sustained throughout the rest of 1987 and 1988, as the recovery in U.S. industrial markets gains steam. By the end of this year, backlogs will be about $1 billion above present levels.

Shipments

First-quarter shipments of electronic components totaled $11.8 billion, up from $11.0 billion in the previous quarter. This was the strongest level of shipments since 1984 and was nearly 15% ahead of the cyclical low in late 1985. Recent order gains and evidence of improvement in the industrial sector make prospects for sustained growth over the next 18 months quite good. Even though a seasonal summer slowdown is likely this year, activity is expected to match first-quarter levels. Toward year-end, the tempo should pick up sharply, which will carry annual shipments to $48.6 billion, a gain of 10.5%.

Inventory-to-shipments ratio

The ratio of component manufacturers' inventories to shipments fell slightly in the first quarter, to 1.97 from an average of 2.06 in the previous three months. This decrease was a result of continued tight inventory controls by manufacturers and solid, expansionary gains in shipment volumes. On a seasonally adjusted basis, total inventories dropped by 0.2% during the quarter, while shipments posted an overall increase of 4.6%. The I/S ratio is expected to hold relatively stable through the summer, but will then edge down for several quarters as the unfolding expansion brings proportionately larger gains in shipments than in inventories.

COMMUNICATIONS

Datacommunications applications spawn new fiber optics markets

U.S. chip makers and other component makers are gearing up for a market which is growing 35% a year

Fiber optics — the newest transmission medium of telecommunications — is finally gaining ground in the field of datacommunications, thanks, in part, to the Fiber Distributed Data Interface (FDDI) standards for fiber-optic local area networks. Most of these standards are expected to be finalized this year.

Nailing down these standards "will help in terms of stimulating the implementation of fiber optics in the datacommunication world," says Warren Anderson, director of marketing at connector company Amphenol Corp.'s Fiber Optic Operations in Lisle, Ill. According to Anderson, "FDDI will bring a flurry of new applications and new systems."

Already, the U.S. market for fiber-optic datacommunications products — including transmitters and receivers, connectors and cable — has reached $137 million, and the future is looking bright. Growing at a compounded annual rate of 35%, this market is expected to reach $812 million by 1992, according to Kessler Marketing Intelligence, a Newport, Rhode Island-based research and consulting firm that specializes in fiber optics.

But this may be only the tip of the iceberg. FDDI will set specifications for both hardware and software products that address both the physical and data-link layers of the Open Systems Interconnect (OSI) model — from defining the characteristics of the transmitters and receivers, which switch electronic signals to light and vice versa, to defining protocols that will allow terminals to access information on the network.

All of this translates into a variety of opportunities for vendors from semiconductor manufacturers — which are already developing FDDI chip sets — to computer manufacturers — which need to develop faster hardware and software.

In computer applications, fiber networks offer more capability than the data-processing equipment they serve. Fiber networks that adhere to FDDI standards will transmit information at a rate of 100 megabits per second. Hence, at the desktop level, fiber optics is "a solution waiting for a problem," comments Albert Bender, president of FiberCom Inc., a Roanoke, Virginia-based manufacturer of fiber-optic networking systems, whose revenue doubled during 1986 to $11 million. Today, he adds, "we're waiting for computers to catch up to what we can do."

> Acceptance of any standard involves more than publishing specifications. De facto standards are set by the proliferation of products following those standards

That day may come by 1992, according to Howard Salwen, chairman and chief technical officer at Proteon Inc., a local area network vendor based in Westborough, Mass. By then, Salwen foresees "PCs everywhere," and the advent of 10 million instructions per second (MIPS) machines. While computer manufacturers are playing catch-up, vendors of fiber-optic products, from components to systems, are not standing still.

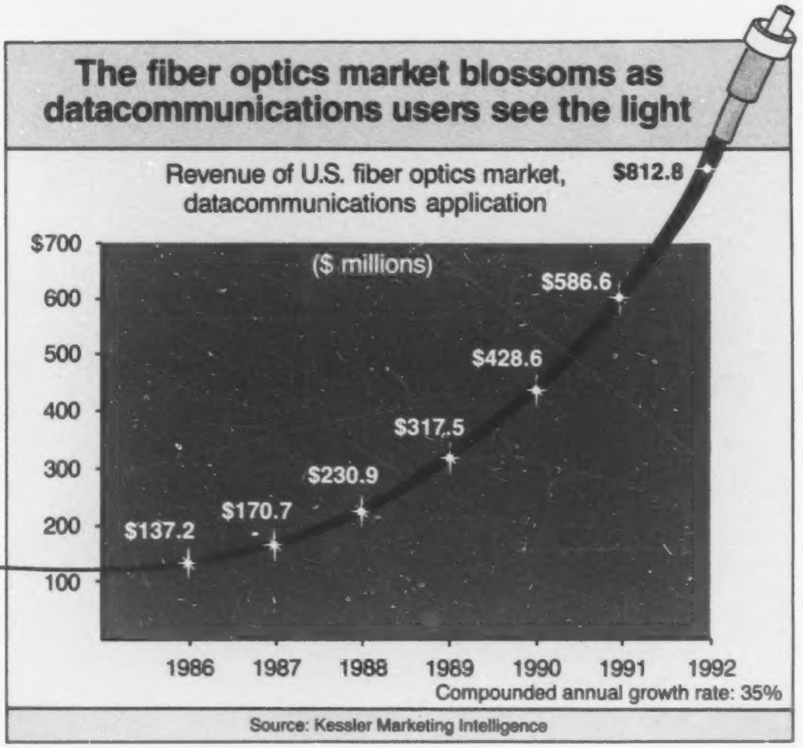
Fibronics International, a vendor of fiber networks based in Hyannis, Mass., has already announced an FDDI LAN. At about $70,000 per node, some say the product is a bit pricey. But, as Gene Milligan, FDDI committee chairman and the manager of business and product planning at Magnetic Peripherals Inc., Oklahoma City, Okla., points out, acceptance of any standard involves more than publishing a set of specifications. De facto standards are set by the proliferation of products that follow those standards. Fibronics' product is an indication that vendors are already giving credence to FDDI. Even Digital Equipment Corp., which has one of the largest installed bases of Ethernet networks, is not ignoring what could become the data networking scheme of the future. This past spring, the Maynard, Massachusetts-based company ran a full-page employment advertisement in a Boston newspaper which indicated that DEC was putting together an FDDI staff.

In the chips

Beyond the offerings of network vendors, Milligan points out that the availability of very large scale integrated (VLSI) FDDI chip sets will be a "key aspect" in promoting wide acceptance of this standard. A number of semiconductor manufacturers are already working on the development of these chip sets, including California-based Advanced Micro Devices Inc. (AMD) in Sunnyvale, and National Semiconductor Corp., in Santa Clara.

The potential customer base for these VLSI components is widespread, from the makers of transmitters and receivers, to fiber-optic network system houses, to manufacturers of computers and peripherals. Proteon's chairman, Salwen, suggests that the market for these chips could eventually become as significant as the market for microprocessors. In fact, Salwen says he is already "waiting for the opportunity" to buy these components, and he is not alone.

FiberCom's Bender believes that the sophistication in fiber-optic datacommunication networks is in the



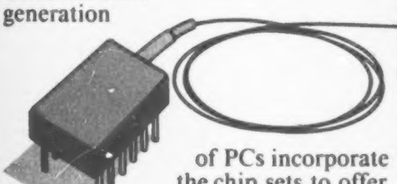
The fiber optics market blossoms as datacommunications users see the light

Revenue of U.S. fiber optics market, datacommunications application

Compounded annual growth rate: 35%

Source: Kessler Marketing Intelligence

electronics. Consequently, the company designs its own custom integrated circuits, which are manufactured by Gould Inc.'s AMI Semiconductors, LSI Logic Corp. and Toshiba foundries. Estimating first generation FDDI chip sets being shipped at a rate of about 50,000 units a month, at a price of about $100 a set, he foresees a $5 million a month market. Once the next generation of PCs incorporate the chip sets to offer FDDI capability, the market will be even greater, Bender adds.



Selling chips to network systems houses and the manufacturers of communication servers will represent a healthy market, suggests Steven Dines, director for strategic development for AMD's Logic Products Division. But the real bounty, Dines adds, will come from sales to data-processing and workstation vendors.

Some workstation companies agree. When the FDDI specifications are finalized, Apollo will be "ready to move very quickly" toward introducing FDDI-compatible product, according to David McCrabb, senior product manager for network products at Apollo Computer Inc. in Chelmsford, Mass.

A connector consensus

Standards are also an issue for connector manufacturers, many of whom are eager to grab a piece of this emerging market. AT&T's patented ST connector already is turning into a de facto standard within the fiber optics marketplace, according to Joseph Denny, senior product planner at the company's Norcross, Ga., facility. Since February 1985, when the connector was introduced and enough of its specifications were published to allow other vendors to build interchangeable ST connectors, a number of other vendors, according to Denny, have developed "ST-compatible" connectors including: AMP Inc., Dorran Photonics Inc./3M, GTE Corp., Optical Fiber Technologies Inc. (OFTI) and Siecor Corp.

Today, AT&T is also working on an FDDI connector. Denny expects, however, that the eventual proliferation of FDDI connectors will have very little impact on revenue from its ST product. The FDDI standard is very specific in terms of what can or cannot plug into the network, he says, but ST connectors can be used in a myriad of networking situations. Amphenol's Anderson agrees. "FDDI will cause the market to grow," he says, but rather than cut into existing component segments.

The overall market for fiber-optic connectors is currently valued at $52 million, and is expected to reach $145 million by 1992

The overall market for fiber-optic connectors is currently valued at $52 million, and is expected to reach $145 million by 1992, reflecting a 24% compounded annual growth rate, according to Kenneth Fleck, president of connector market analysis firm Fleck Telesis Inc., in Huntington Beach, Calif. Fleck says that although telecommunications has traditionally represented two-thirds — 60% — of the market over the past five years, "datacomm will become an increasing share of this pie."

However, as the market shifts, so might the customer base. Currently, approximately 70% of Amphenol's datacommunications fiber-optic connector revenue comes from systems houses such as Codenoll Technology Corp., FiberCom, Fibronics and Siecor, estimates Amphenol's director of marketing Anderson. But, as the embedded base of fiber-optic networks expand and technology reaches the point where capabilities will be cost effectively embedded in computers, Anderson expects the customer base will eventually shift to computer and peripherals manufacturers such as Data General Corp., Digital Equipment Corp., IBM and Wang Laboratories Inc.

CAROL SUBY

SEMICONDUCTORS

Chips for toys: A market built by demanding tots

Toy makers last year shipped $543 million worth of electronic toys. That's not a market IC makers can ignore

There is no such thing as a sure bet in the toy business. Ask any semiconductor vendor and he'll say that the payoffs can be tremendous, but that the risks can be just as great.

What is the allure, and why are an increasing number of semiconductor vendors entering the high-technology toy market? The reason is numbers — 60 million consumers of toys versus six million for personal computers.

Toys are also sexy — flashy advertisements, heavy marketing dollars, and a whole slew of trendy teenagers with large disposable incomes ready to consume the latest hit. The average family, each year, spends $200 per child on toys. In spite of the relatively high price point of some of the new and popular electronic toys (often between $75 and $150), that is a lot of toys.

And the number of electronic toys is increasing, and will likely continue to increase over the next few years. Estimates from market research firm Dataquest Inc. indicate that shipments of electronic games in North America will grow from $543 million in 1986 to $691 million in 1990. When a product does hit, it can hit big. "You can go from zero to 200,000 units in no time at all," says Zilog Inc. president and chief executive Edgar A. Sack.

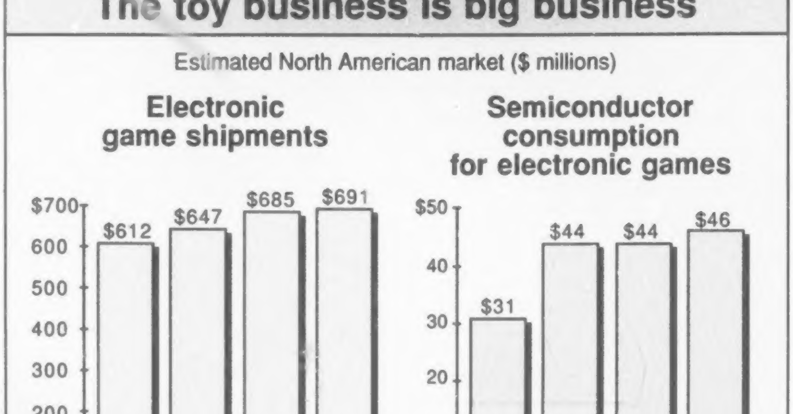
In fact, almost all of the major toy manufacturers have a semiconductor-intensive offering of some sort, and a number of smaller companies, including Lewis Goloob Toys of South San Francisco, and Worlds of Wonder Inc., Fremont, Calif., have made a niche for themselves with electronic toys. "The only way high-tech toys would go away is if the market decides they are not any good," says Worlds of Wonder engineering vice president David Small. Small says that his company's IC usage has skyrocketed since introducing its first electronic toy three years ago.

What started out as the video game craze in the early 1980s with companies like Atari Corp. has expanded to include dolls that talk, souped-up versions of video games with enhanced graphics, radio-controlled toys and infrared-sensitive toys. The semiconductor content of each of these products varies, from less than 5% of the wholesale price to 20% or higher, depending on the type of toy and the target audience.

According to Standard and Poor's Corp. toy and electronics analyst Paul Valentine, the electronics industry has benefited from recent changes in the toy industry. "The toy industry is shifting from fantasy to high-tech toys," he says. "Toys are a fashion business, and from period to period tastes change and this is one of those times." However, Valentine is disappointed by sales of electronic toys, which he says have been relatively flat. He attributes this to the relatively high price tags for most products.

But breaking into this market may be difficult for the uninitiated. For a

The toy business is big business



Source: Dataquest Inc.

semiconductor vendor to effectively compete, he must do four things, according to Zilog's Sack: Keep quality up, costs down, and turnaround times short, in addition to keeping a tight rein on inventory levels. As Stan Katz, National Semiconductor Corp.'s microcontroller strategic marketing manager, points out, the annual New York City Toy Fair, which is the industry's primary trade gathering before the Christmas shopping season begins, occurs in early February. "At best, we get some insight into the products in early February, and then the toy companies go ahead and turn us on [to what they are planning]," Katz says. "We take our product line and have one month to write the code, sometimes billions of pieces, and we have to work with all the pressures of delivery dates, costs and reliability."

Commodity items

Probably the best way a semiconductor vendor can control the pressures is to work with standard, off-the-shelf products in order to limit the investment. NEC Corp., for example, claims to be the world's largest merchant of 4-bit microcontrollers, selling over 60 million of those chips per year.

But, despite the differences, toy companies buy semiconductors just like any other company, says Axlon Inc. president Nolan Bushnell, also founder and former president of Atari Corp. "One area [in which] we are different, however, is we don't have a huge budget. The toy business is cost competitive, and you want more technology for fewer dollars," says Bushnell. Toy companies also uhave a broad technology base, according to Worlds of Wonder's Small. His company buys parts that span the range from microprocessors and microcontrollers, to digital signal processors and infrared technology. Toy manufacturers are heavy users of semicustom parts, says Small, because of the short leadtimes to market. As products mature, parts go to full custom to bring prices down.

However, the collapse of the video game market in 1981-1982 has left a sour taste in the mouths of several semiconductor companies. "This company was badly burned in providing a chip for [an electronic] chess game," Zilog's Sack recalls. "It lost its taste for the toy market, but we are now putting our toes in the water again. But we are not going to overextend ourselves, and we don't want to go full bore all at once." The bottom line in the toy market, Sack stresses, is that it is seasonal and trendy.

Hit or miss

The most difficult issue facing semiconductor vendors trying to enter the market is the marketing-driven nature of the toy business. Toys are faddish, and a hit product one season is more often than not dead the next. Oftentimes, one hit product is enough to make a tidy profit, but the question is, how can a supplier not in the toy business judge what is going to be a hit?

National's Katz says that he has stopped using his intuition, and instead reaches for companies which have a known track record that he can trust. "The hardest area to be in is toys," he says.

Texas Instruments Inc., however, may have solved this problem by viewing its relationship with toy manufacturers as almost a joint development situation — with TI providing the technology and the toy companies supplying their knowledge of the market.

"We have been working with Worlds of Wonder for over a year on a project [the "Julie" doll]," adds TI's voice applications manager Gene Frank, "and it ended up being a joint effort to bring together four or five different aspects of technology — including speech recognition and synthesis, digital signal processor technology and a lot of systems capabilities combining together to do a design."

Some semiconductor vendors also feel that participation in the toy market — to a limited extent — can help offset the cyclical nature of more technology-intensive businesses. Some analysts theorize that during a recession more toys are bought than at other times. Consumers buy toys, perceived as "soft goods," during a recession because of the high price of consumer "hard goods" — televisions, stereos, automobiles, etc. "Toys are countercyclical," says Zilog's Sacks. "You are selling low-end products while big ticket items are in the tank. That's another reason manufacturers must balance their businesses. When military is down, toys are up."

VALERIE RICE

New toy fads

First there was the landmark video game Pong, then other personal arcade games, and then the great fall from grace. Finally, about two years ago, Teddy Ruxpin from Fremont, California-based Worlds of Wonder Inc., came along and engaged the minds (and pocketbooks) of children.

In terms of semiconductors, voice- and speech-recognition chips are currently the hot items, and as vocabularies increase, memory contents will likely increase as well. Talking dolls are the current fad, as well as any stuffed toy that allows interaction such as Axlon Inc.'s Petster line. Teddy Ruxpin has a whole family of products now, and Worlds of Wonder is said to be coming out with a new doll called "Julie" which features both speech recognition and synthesis. Mattel Inc. has a baby doll that actually ages from 6 months to 2 years of age by making different sounds and gestures.

Other hot areas are infrared-sensitive games such as LazerTag, from Worlds of Wonder, and Photon. Television interactive games are probably the hottest new item this year and are of a somewhat different breed than video games. Axlon Inc.'s Tech Force is a series of remote-controlled, programmable robots that can be manipulated either from a computer console or from sounds generated from a cartoon series produced by Axlon called "Tech Force and the Moto Monsters." Although Axlon is not sure when it will be able to broadcast its cartoon series (and certain parents' groups have raised objections to the concept) there are other companies planning similar entries including Mattel's Captain Power. Captain Power is an interactive game and cartoon where children can shoot laser guns at characters in the cartoon.

"Television entertainment games will be with us until the cows come home," says Axlon president Nolan Bushnell. But beware, high-tech toys may not be in the rage forever, Standard and Poor's Corp. analyst Paul Valentine predicts, because, he says, there are a number of very innovative toys on the horizon that don't use semiconductor chips at all. ☐

MANAGEMENT

Japan in America: Living in the U.S.A.

Japanese companies are racing to develop U.S.-flavored subsidiaries. But mixing sushi and hamburgers isn't easy

By Mike Leibowitz

The race is on to Americanize. Major Japanese industrial electronics firms have begun staffing their middle-level and upper-level U.S. positions with Americans — positions previously held by Japanese nationals. The Japanese firms have also started to open U.S. manufacturing plants and engineering centers. And they vow that this effort to look and act as American companies do is only the beginning.

Actually, the Americanization process is part of the larger goal of becoming global companies, according to Japanese executives. As examples, they point to multinational companies, such as IBM and Philips, which research, develop, manufacture and market their products in major market locations around the globe using local labor and management. The Japanese see that global companies are viewed as "good citizens" of various nations and can better address the specific needs of local markets.

In their biggest market — the United States — the Japanese call their efforts to become global "Americanization." Americanization not only means setting up local plants and engineering labs, but it also involves management: an area where the Japanese feel a particular urgency.

Americans, they say, are needed to play a new role in Japanese companies — that of marketeers — as their subsidiaries begin to seriously address the needs of U.S. customers. American executives and managers are also necessary to forge alliances with American companies and to build and manage the plants and engineering organizations. And Americans are required to set the subsidiary's direction in the difficult political and legal environment which exists for many Japanese companies in the States.

But possibly the most compelling reason to Americanize, some executives admit, is public relations. Faced with boiling-level trade tensions, Americanization helps to satisfy an angry Congress and American public who are beginning to see Japanese companies, which have been grabbing American markets, finally "turning American."

> Faced with boiling-level trade tensions, Americanization helps to satisfy an angry Congress and American public

"We must be recognized as a good American company, a good American citizen" says Tsuneo Tanaka, president of Hitachi America Ltd. "Especially in this very difficult period of trade friction."

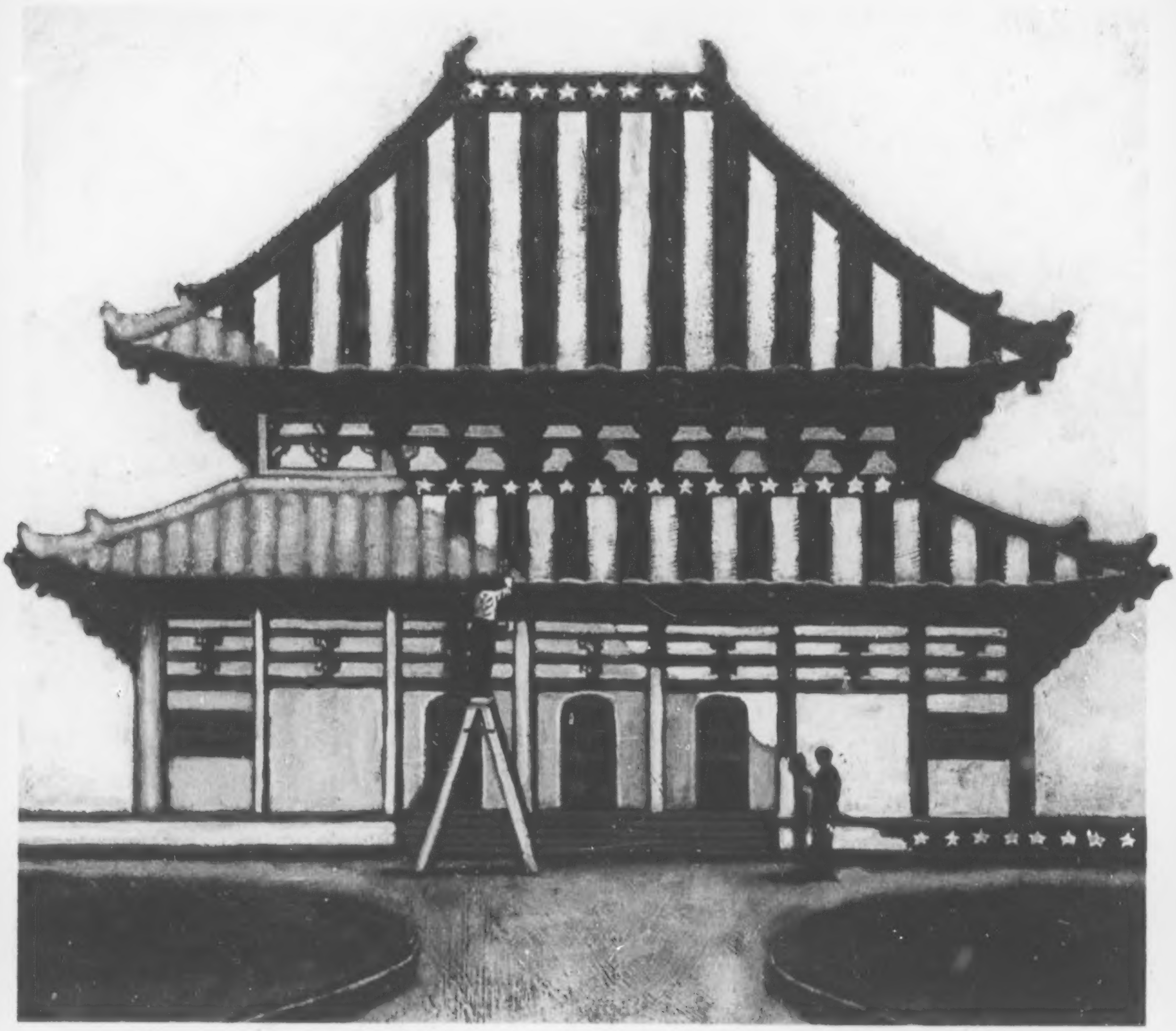
In the interest of Americanization, Hitachi Ltd. — which had 1986 U.S. sales of $3.7 billion and employs 3,500 Americans — has consolidated its five separate U.S. manufacturing subsidiaries into its main U.S. sales and marketing subsidiary, Hitachi America Ltd. The purpose, says president Tanaka, is to enable the subsidiary to expand into a standalone "Americanized" company. And as a keystone of this Americanization plan, Tanaka says that he will replace the Japanese general managers of 10 sales and marketing divisions with Americans during the next five years.

Fujitsu Ltd., which had U.S. sales of $1.1 billion in 1986, is considered by many to be at the forefront of Americanization among Japanese industrials. The company employs 4,000 Americans, including 800 staffers employed in a recently established joint venture with GTE Corp. Fujitsu America Inc. — the company's largest subsidiary and the one responsible for sales, marketing and some manufacturing of all of Fujitsu's nonsemiconductor and electronic component products — already has six American division and organization heads, out of a total of nine, not including its joint venture. In addition to gradually expanding manufacturing and engineering efforts in the United States, Masaka Ogi, Fujitsu America's president, expects to place even more Americans in executive positions.

Important plans

These plans are important because, increasingly, more American managers are finding themselves drawn to Japanese companies. For many managers, U.S. subsidiaries represent the new, wide-open job frontier. While American companies have been laying off and slimming down, Japanese companies have been expanding their operations in the States.

Once hired, an American manager can count on staying at the company. Whether the American joins a new division that finds difficulty getting off the ground or an established division that faces a downturn in business, Japanese companies tend to re-



Scott Gordley

Japanese companies in America paint themselves red white and blue.

main committed to their markets and their employees.

Other reasons for climbing aboard, American managers say, is the desire to learn how Japanese companies work and to further their own careers either within or outside that company. Many managers believe that working for a Japanese company increases their future value in the job market.

But, some managers cite the challenge of helping to build a business as what attracted them to a Japanese firm. John Familetti left his general manager's post at Penril Corp.'s Data Communications Division four years ago to start up Fujitsu America'sTelecommunications Division in a rented office in Virginia. With the help of a Japanese engineer he devised a business plan, got it approved, and has grown the sales and marketing operation into a 170-employee division. Familetti, 55, says that Fujitsu's commitment to the market and the likelihood of success made the opportunity to start the division seem particularly desirable.

William Gsand, 43, joining Hitachi America's Semiconductor and I.C. Division as vice president, got himself aboard a $35 billion company that he says is best positioned to grow in the turbulent semiconductor business. "I think you're going to see the big Japanese companies of this industry dominating over the next five years," says Gsand, who left General Instrument Corp. where he was a vice president for marketing in the microelectronics division.

A critical assessment

But, even though Japanese companies expand their operations in the United States and hire American middle- and upper-level managers, critics question whether this is really "Americanization."

"Where are we on Americanization?" asks Clifford Clark, a former Stanford University professor of international management and consultant to Japanese companies. "On a scale of one to 10 we are a two."

"The doors and the windows and the buildings are physically the same [as in American companies]," says William Morrison, who spent 18 months with Fujitsu Microelectronics Inc. as a marketing manager. "Beyond that, I don't believe that the Japanese companies in the U.S. are Americanized whatsoever."

"I don't believe it for a minute," says Matthew Crugnale of Crugnale & Associates, a marketing consultant to Japanese firms, when asked whether U.S. subsidiaries are Americanizing. "I think the company will have an American coat, but a Japanese shirt and underwear."

The reason for the low marks on Americanization, critics claim, is that even though many Japanese companies have placed Americans in middle- and upper-level management positions, they are given little control over the operation and direction of the subsidiary. They are being asked to fit within a fundamentally Japanese management system, which keeps the subsidiary tightly coupled to the Japanese parent. Critics say that it is the actual authority which the Japanese give to American managers, not the American-manager head count, that determines effective Americanization.

"When you get down to the nitty-gritty of what Americanization is," says Clark, "it is a decision-making process that gives authority to the American input. The Japanese won't let [an American manager] make decisions. You get all the responsibility. You don't get any authority."

American managers at U.S. subsidiaries are often given far less authority than their titles imply, according to critics. They point to the fact that Japanese nationals in the United States and Japan tend to influence many decisions that a manager may make, ranging from personnel hiring and promotion, product specification, advertising and pricing to approving a subordinate's travel plans.

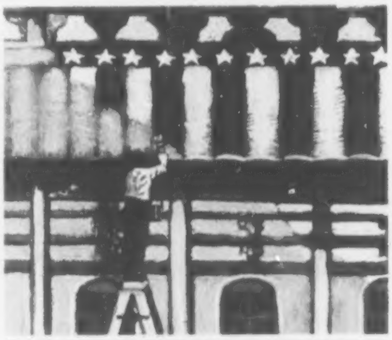
Clark cites an example: an American finance manager of a Japanese firm's U.S. subsidiary who is unable to sign checks. "He's frustrated as hell," says Clark. A Japanese clerk signs all of the checks.

William Garraty, vice president and deputy general manager of Hitachi's Telecom Division, acknowledges that his authority in personnel decisions is lower than it would be at an American company. At a U.S. company, he would be able to grant promotions, raises and job changes. At his division, however, the Japanese general manager makes decisions such as these autonomously. "It tends to come down as an edict," says Garraty. In the Japanese culture, he explains, "the top manager is supposed to know his people, know their strengths and weaknesses, and doesn't need much help in making those decisions."

Despite what appears to be acceptance of the Japanese culture by many American managers at U.S. subsidiaries, lack of authority still produces frustration.

"You would expect that there are certain areas in which you have ultimate authority — that you shouldn't even consider copying anyone else on certain decisions," says Hitachi's Gsand. However, as a courtesy, you do, says Gsand. "Many times, that courtesy is returned by a [response]: 'We should study that further before we make that final decision.' "

Unfortunately, granting the authority necessary for Americanization is not a simple task. For one thing, some of the denial in authority is legitimate. Many functions of U.S. subsidiaries are tightly woven into the operations of the parent company. For example, information necessary to specify new products or modifications to existing products — which are engineering and manufacturing-based decisions in a Japanese company — reside in Japan. The ability to quote aggressive pricing and delivery of commodity products depends on a firm's other worldwide commitments and financial objectives.



According to critics, American managers at U.S. subsidiaries are often given far less authority than their titles imply

But some of this lack of authority is fundamental to the Japanese consensus management system, which shuns individual decision-making in favor of a heavily detail-oriented, bottom-up, team approach. Consensus management involves consultation and information-sharing among many individuals. Proponents say that it is the best way to make decisions. Opponents say that it is painfully slow and inadequate for coping with fast-moving markets. American managers, however, have no choice in this issue, they must adopt consensus management. It is a fundamental part of the culture that the Japanese have exported to their U.S. subsidiaries.

Others say that the big problem holding back authority is a distrust of American managers by the Japanese. According to Vladimir Pucik, professor of international management at the University of Michigan, "lack of trust" is the most common complaint voiced by American managers working for Japanese firms.

Do the Japanese actually distrust their American employees? "Oh yes — no question about it," contends Pucik, who studies management problems at U.S. subsidiaries. Distrust is related to a fundamental difference in culture, according to Pucik. The Japanese tend to view the average American, who works shorter hours and who often changes jobs every few years, as being a less-dedicated, short-term employee. The Japanese, in contrast, typically spend their entire careers at the same company. They are naturally wary of trusting someone who may soon leave to go to a competitor, says Pucik.

Initial credibility

American managers complain that the problem of getting authority and information is most pronounced in the initial "credibility-building period," during which, American managers strive to build relationships and demonstrate competence and dedication. The period lasts between one and three years, according to American managers.

Actually, credibility-building is an ongoing process, says Michael Brown, Western regional manager for Hitachi America's Semiconductor and I.C. Division. "The longer you're here the more trust and confidence they have in you," says Brown. "Five years is one step, 10 years is another. After 20 years they trust you — they figure you're going to be around."

Vice president Gsand, after spending one year at Hitachi, says that his Japanese boss still demands detailed proof that issues are being watched. "Rather than me saying: 'Don't worry about it, it's being taken care of' — the detail has to be there," says Gsand. He says that the Japanese do not assume that "this guy has got the experience — he understands his market — we should trust him."

And Gsand, second in command at his division, says that obtaining the information necessary to do your job is sometimes difficult. "If there's a question asked, [Americans] will give four answers to that question. The Japanese will give half an answer," says Gsand. "Many times you'll get an answer exactly to the question you asked, without any expansion." This, says Gsand, makes it difficult to make decisions that require a great deal of information.

Gsand is next in line for the general manager's position at his division, but he accepts these frustrations as part of working for a Japanese company. He says that these difficulties are more than outweighed by the opportunities that a Japanese company provides to an American manager.

But some managers are not that patient. Clark cites an example of a particular Japanese company that has a 40% turnover rate among its American managers. According to the consultant this is due to a lack of authority and trust, slow promotion, and lack of training given to American managers.

Actually, turnover of U.S. managers at many Japanese firms is "a vicious circle," that feeds upon itself, says Pucik. Authority and trust are given to American executives and managers who stay for relatively long periods of time at Japanese companies. But, if Americans do not receive authority and trust soon enyough, then they leave. This makes the Japanese even more reluctant to invest

Fujitsu's happy story

Fujitsu Ltd. has a good story to tell America. Between its two operations in the United States, Fujitsu America Inc. (FAI) and Fujitsu Microelectronics Inc., the company appears to be ahead of the rest of the pack in Americanizing. The operations are proud of their mostly American management and are eager to show off.

Masaka Ogi, FAI's president, proudly points to FAI's low management turnover, which he attributes partially to FAI paying its managers well. "I think we have to give some more compensations to [American managers] because they are working under a different culture."

Some happy executives at FAI say that Fujitsu has simply been better at integrating the Japanese consensus management style into its American organization. They mention training provided by Fujitsu's Hawaii-based Japan-America Institute of Management Science as one of the factors that has helped employees adapt.

Others at the company point to an extensive interviewing process that FAI uses to weed out managerial candidates whose personalities will not fit into FAI's culture. According to Arthur Gemmel, senior vice president who oversees the human resources effort at FAI, a candidate will often meet with eight people over a period of three days. On the second and third days, says Gemmel, "We're interviewing for personality." Adaptability, patience and interest in working in the Japanese culture are the things that executives look for in deciding whether or not a candidate will fit in. According to Gemmel, all eight Japanese and American interviewers must agree on the choice of manager. "If anyone says no than he's out," says Gemmel.

Concerning further Americanization plans, president Ogi says that he expects to move quickly in transferring research and development activities to the United States, and he intends to gradually increase the level of manufacturing done at existing facilities during the next three years. He would not state specific plans, however. On raising the percentage of Americans at the executive level, Ogi says that this may increase another 10% to approximately 65% during the next four years.

Senior vice president Gemmel, who often acts as FAI's spokesman on Americanization, does not think FAI has any more to gain by replacing the Japanese nationals in the company with Americans. He puts FAI's current Americanization level at almost a nine on a scale of one to 10.

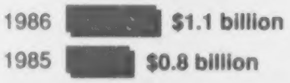
"I'm not sure that I want to go beyond nine," says Gemmel. "The fact of the matter is, we are Japanese-owned. We need the Japanese influence here, we need the communication bridge to Tokyo, and we need to understand Fujitsu Ltd.'s philosophy as it evolves. We need to understand the product development taking place in Japan. We need a senior Japanese influence pushing for Fujitsu America at the most senior levels in the company." □

Fujitsu Ltd.

Worldwide 1986 sales:
$12.3 billion
(Fiscal year ended March 1987)

Number of employees
worldwide: **84,000**

U.S sales:



Total number of employees
in U.S.: **4,134**
(includes 870 employees in Fujitsu-GTE joint venture, begun 4/87)

Source: Fujitsu subsidiaries, Dataquest Inc.

MASAKA OGI, president of Fujitsu America: "I think we have to give some more compensations to [American managers] because they are working under a different culture" their trust and training in the next manager because they fear the same thing will happen.

All of this tends to discourage aggressive managers who hire on expecting to pursue a fast track at a Japanese company. John Familetti, senior vice president and head of Fujitsu America's Telecommunications Division, gives a bad mark for a job candidate having "an ambition that is bigger than all outdoors."

Charles Kissner, vice president of Fujitsu America's Switching Development Division warns: "A typical manager of a start-up company will have some problems integrating into this culture."

Careful recruiting is a solution that Japanese companies pursue to try to minimize hiring employees that will become dissatisfied and quit. Companies tend to interview more candidates for a given position and take longer to evaluate them than their American counterparts. Prospective managers are often interviewed by as many as eight people, Americans and Japanese. Most important, companies look for a particular mix of qualities that might make a candidate more likely to stay. Patience, adaptability, length of prior employment, and the ability to function as a team player are all virtues that executives say they look for when evaluating candidates.

Despite this careful recruiting process, many Japanese firms still experience a troubling turnover problem among American managers.

Nobou Ishizaka, chairman and chief executive of Toshiba America Inc., says that his turnover problem actually has two sides to it — high turnover and low turnover. "Good people with vigorous minds and ambitions leave," says Ishizaka. "But the people on the opposite end stay."

Japanese firms believe one solution to retaining capable employees is to teach them Japanese management practices and culture. Fujitsu America trains certain employees using the Fujitsu-cosponsored Japan-America Institute for Management Science. Some companies are consid-

Hitachi: The American imperative

When Tsuneo Tanaka came to America two years ago to assume leadership of Hitachi Ltd.'s U.S. sales and marketing subsidiary, Hitachi America Ltd., he did not believe the company would Americanize quickly. Morale was low among American managers, turnover was high, and "policies were made in Japan," says Tanaka. And unfortunately, he says, Hitachi's executives in Japan did not realize the importance of Americanization.

Now, they realize it. Trade friction, says Tanaka, has accounted for a new sense of urgency to Americanize at Hitachi. It resulted in a major reorganization of the U.S. operations and paved the way for a series of steps that Tanaka hopes will Americanize his $1 billion subsidiary. Tanaka has his new marching orders: "I have to operate this company as an American company."

Last April, Hitachi consolidated the company's five U.S. manufacturing subsidiaries under Tanaka's organization, yanking them away from the direct control of their Japan-based parent factories. This reorganization was done to allow Hitachi America to eventually become a standalone company, says Tanaka.

After integrating the manufacturing groups into Hitachi America, Hitachi's goal is to establish a research and development group in the United States that would develop products for the American market. This, Tanaka says, will occur within the next three years. Currently, Hitachi has no U.S.-based R&D.

In manufacturing, the company recently opened a 100-employee disk-drive assembly plant and plans to begin manufacturing private branch exchanges (PBXs) in Atlanta this year. The Irving, Texas, integrated-circuit assembly plant, however, remains void of semiconductor production equipment, pending a recovery in the semiconductor market. Production, which was scheduled for early 1987, is now planned tentatively for 1988. "We must be very careful," says Tanaka. "This is a big investment."

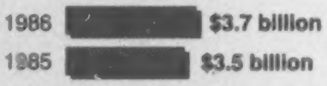
But the big change, says Tanaka, will occur during the next five years as Hitachi America replaces the Japanese general managers of its 10 sales and marketing subsidiaries with American managers. Already, Tanaka has promoted Americans in four divisions to the rank of deputy general manager, and he expects to promote two of these managers to the position of general manager this year. When this happens, Tanaka will place a Japanese national in the role of deputy general manager, to provide "support" to the American head. ☐

Hitachi Ltd.

Worldwide 1986 sales:
$34.6 billion
(Fiscal year ended March 1987)

Number of employees
worldwide: **164,000**

U.S sales:



Total number of employees
in U.S.: **4,000**

Source: Hitachi America Ltd.

TSUNEO TANAKA, president of Hitachi America: "I have to operate this company as an American company" ering expanding their training programs to include all managers upon hiring.

But, recruiting and training does not solve the problem of Americanization. Even if companies were to solve their problems with attracting and retaining top-notch American managers, the problems concerning handing the reins of control over to Americans would still exist.

The formidable task

The one step that many believe is necessary for Americanization is for Japanese companies to change the structure of their U.S. subsidiaries to make them less integrated with the Japanese parent. Only by loosening the structural ties between the Japanese parent and its U.S. subsidiaries will any single group of management be able to run the subsidiary.

By far, this is the most formidable task. Today, even though Japanese companies have brought some of their manufacturing processes over to the States, most of it, along with virtually all of the research and development, remains in Japan.

But the problem is not solved merely by moving more manufacturing to the United States. So far, Japanese strategies of establishing assembly operations in the United States have included increasing the interaction between the parent and subsidiary instead of decreasing it. Now, for example, interaction is required between the assembly operation in America, and the main plant and the R&D groups in Japan.

Some experts, who are doubtful about the prospects for Americanization, do not think that the Japanese will ever let Americans run manufacturing, even if they were to make their U.S. operations a standalone unit. They say that the Japanese believe that they do it better, and experts concede that they probably do.

Toshiba America's chairman Ishizaka agrees that the only solution to the problem of Americanization is to turn subsidiaries into "self-contained, self-standing businesses." He is also pessimistic about this happening soon and is critical of his competitors' that claim to be Americanizing.

Ishizaka says that Americanization will only occur after Japan changes. He believes that Japan's homogeneous people and culture prevent it from handing the control of its companies over to someone else. America's diversity, in contrast, has allowed U.S. companies to move further in "Japanizing" their Japanese subsidiaries.

"Americanization of Japanese companies is a reflection of what's happening in Japan," says chairman Ishizaka. "There's no short-term solution. I really think it is premature to talk about Americanization."

Toshiba: A standalone objective

"Of course we plan for greater local production," says Nobou Ishizaka, chairman and chief executive of Toshiba Ltd.'s $2 billion U.S. subsidiary, Toshiba America Inc. "We plan for promoting, and getting good Americans. But right now, that situation, for various different reasons, looks pretty gloomy."

The reason that chairman Ishizaka is not bullish about the prospects for Americanization at Toshiba America, or any other Japanese company for that matter, is that merely hiring Americans for top posts at their subsidiaries is putting the cart before the horse. Subsidiaries cannot become truly Americanized until they become "a self-contained, self-standing business," he says.

Americanization at U.S. sales subsidiaries was proceeding well until Japanese companies started manufacturing in the United States, according to Ishizaka. Then management control by Japan increased, instead of decreased. "Japan planned the factory and controlled the supply of crucial components," says Ishizaka. American managers had to settle for far less authority than they would at an American company.

Consequently, subsidiaries now have difficulty keeping good American managers. Also, not having the ability to offer stock options deprives them of a key tool necessary to attract and hold first-rate American executives.

The result is an environment unsuited for attracting and keeping good, capable managers, Ishizaka believes.

Instead of merely trying to hire more American managers, Ishizaka says, "the objective should be to make the American operation one in which Americans would be happy to work, American investors would be happy to buy shares, and the American public would like to deal with. That is real Americanization."

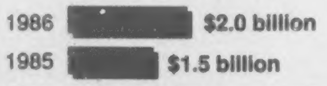
Until this happens, Ishizaka says, "it is too premature to talk about Americanization. It is only talk."

Toshiba Ltd.

Worldwide 1986 sales:
$23.6 billion
(Fiscal year ended March 1987)

Number of employees
worldwide: **120,000**

U.S sales:



Total number of employees
in U.S.: **3,120**

Source: Toshiba Ltd.

NOBOU ISHIZAKA, chairman and chief executive of Toshiba America: "We plan for promoting, and getting good Americans. But right now, that situation, for various different reasons, looks pretty gloomy"

DISTRIBUTION

Industrial distributors are cautiously optimistic

An exclusive ELECTRONIC BUSINESS survey suggests all the signs are pointing to a continued second-half upturn

By Bruce C.P. Rayner

Cautious optimism. That is the best way to describe the mood of industrial distributors.

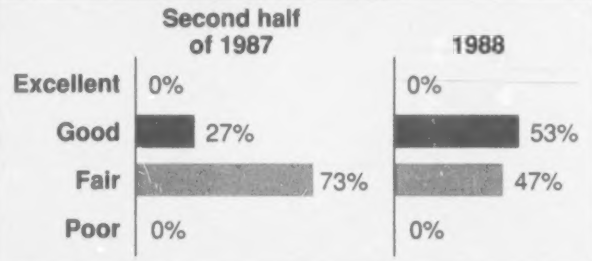
A recent in-depth survey by ELECTRONIC BUSINESS of 15 leading U.S. distributors confirms industry estimates that revenue will grow about 10% this year and 10% to 15% in 1988. The survey was conducted this spring by the magazine's in-house research staff.

About two-thirds of the respondents to our questionnaire — which was mailed to 50 distributors in all — indicated that the economic outlook for the second half of 1987 will be fair. And about half of those responding described their expectations for the second half as good. Much of the optimism is based on expectations that the computer industry will continue to strengthen, along with several strong semiconductor markets, including 32-bit microprocessors and application-specific integrated circuits (ASICs).

Meanwhile, leadtimes and book-to-bill ratios are stretching out, and many distributors surveyed expect component prices to rise in the second half of 1987. Similarly, many

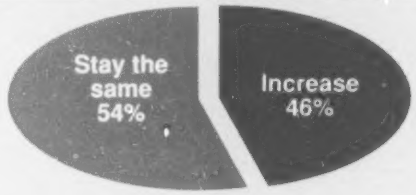
ECONOMIC OUTLOOK

How would you characterize the economic outlook for:



MARGINS

In the next six months, do you expect gross margins to:



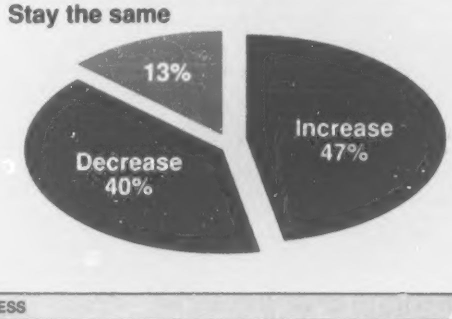
PRICES

Indicate what you expect prices will do in the next six months:

	Increase	Decrease	Stay the same
Semiconductors	84%	8%	8%
256K DRAMs	75%	25%	0%
Connectors	72%	0%	28%
Electromechanical components	46%	0%	54%
Other passives	33%	0%	67%

INVENTORIES

Do you expect your company's inventory levels to increase or decrease in the next six months?



Source: ELECTRONIC BUSINESS

distributors report that the grey market is drying up for some Japanese commodity components. Opinion is split over whether gross margins will hold steady or increase, with 54% of respondents expecting theirs to remain the same.

As long as there are no shortages of components and distributors remain fiercely price competitive, margins will not rise, respondents said. This is likely in the near term. Also contributing to the downward pressure on margins is the shift to computer systems sales. Systems generally carry lower margins than components. Possibly more important is the excess capacity in most component manufacturing plants. As long as capacity remains underutilized, margins could hover in the low 20% range indefinitely.

Another indicator pointing in the wrong direction for distributors is the low number of annual inventory turns. According to the survey results, distributors' annual inventory turns ranged between 2.5 and 5.5 for fiscal year 1986. Clarke Walser, a senior vice president at The Chicago Corp., estimates an average annual inventory turn rate at a low 3.0 for calendar 1986.

With such low inventory turns and stagnant gross margins, Walser doubts whether any distributor can earn a satisfactory return on inventory investment. He worries that distributors will be unable to generate enough capital when the recovery hits full force and they need to increase inventory. Nearly half of the distributors surveyed expect to increase inventory levels in the next six months, 40% expect them to decrease and 13% expect them to stay the same.

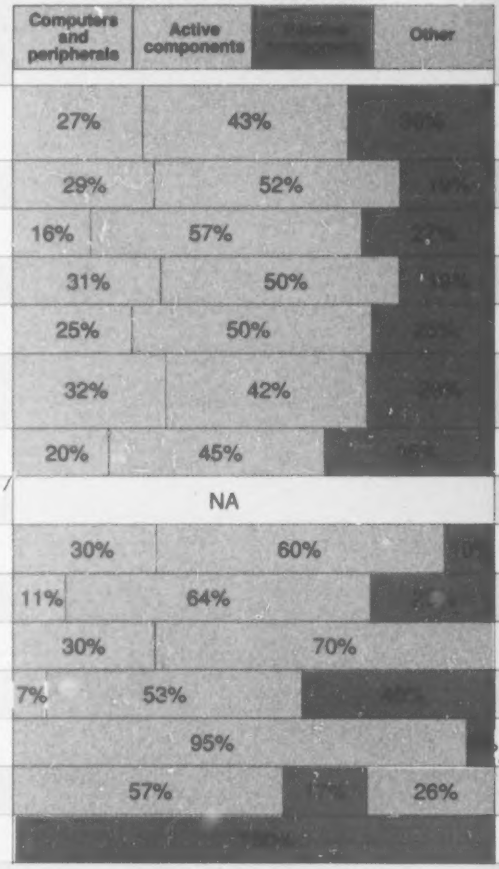
Robert Schrader, president of Port Chester, New York-based Zeus Components Inc., a $92 million distributor in the military market, argues, too, that a turn rate of 4.0 is probably optimal. Anything less gives a low return on assets, while anything higher interferes with customer service, he says.

With increasing trade friction between the United States and Japan, some original equipment manufacturers are also building inventory of Japanese commodity semiconductors

Top 15 U.S. industrial electronics distributors

Rank 1986	Rank 1985	Company	Calendar 1986 sales ($ thousands)	Percentage change from 1985
1	1	Avnet Electronic Marketing Group*	$1,146,420	+11.8%
2	2	Arrow Electronics	501,795	+0.3%
3	3	Lex Electronics	501,000	+38.4%
4	4	Ducommun Electronics	386,600	+11.3%
5	5	Hall-Mark Electronics	385,000	+18.4%
6	6	Pioneer-Standard Electronics	276,000	-2.8%
7	8	Marshall Industries	269,155	+15.5%
8	7	Premier Industries	267,169	+0.8%
9	9	Wyle Electronics	225,000	+13.2%
10	10	Future Electronics	217,400	+9.8%
11	12	Anthem Electronics	167,216	+61.4%
12	11	Bell industries	158,000	+15.4%
13	13	Zeus Components	92,000	+13.9%
14	-	Milgray Electronics	62,004	NA
15	-	TTI	60,707	NA

Sales breakdown by products



* Consists mainly of Hamilton/Avnet and Time Electronics

NA = Not available

as insurance against a possible break in supply. Much of this buffer stock comes from distribution. While prices are expected to increase in general, a full 75% of those surveyed expect the prices of 256K dynamic RAMs to increase in the second half of 1987. Most of the distributors surveyed carry a miniscule quantity of Japanese product (averaging around 1%) and the majority of them expect to keep the inventory of Japanese product constant over the next two years.

Over half expect the U.S. government's "get-tough" trade strategy to benefit the domestic distribution market because, in the near term, shortages always push margins up, creating windfall profits. But in the long run, many distributors agree that additional market uncertainty is unhealthy. The U.S. government's actions only create inequity and instability, complains one distributor.

Diversifying

To counter uncertainty, many distributors are diversifying their product offerings. The top-ranked growth markets for the second half of 1987 are ASICs, computer systems and 32-bit microprocessors, in that order. Top-ranked Avnet Inc., the New York City-based parent of Hamilton/Avnet and Time Electronics, expects its relationship with Digital Equipment Corp. to bring in $500 million in system sales for Avnet by 1990. Other top distributors are following Avnet's lead in the systems market.

As for 32-bit microprocessors, it is only a question of time before they become standard commodity items. As they infiltrate more systems, they are expected to generate both systems and component sales for distributors. Similarly, distributors are getting more involved in ASIC design centers in order to cater to the demand for custom chips by smaller original equipment manufacturers. But profits from ASICs do not materialize until the design enters production. For many distributors, acceptable return on investment in ASIC centers is still a year or two away.

Researched by Nancy McSharry, assistant editor.

Fiscal 1986 sales ($ thousands)	Gross margins	Profit or loss before taxes ($ thousands)	Stocking locations	Number of employees	Inventory turns (per year)	Average receivables (in days)	Fiscal year ended
$1,098,200	25.0%	$17,500	121	9,250	NA	NA	6/86
501,795	21.0%	-28,267	43	2,125	3.3	54	12/86
501,000	23.0%	-4,500	50	1,500	3.5	NA	12/86
386,600	NA	-9,100	30	1,300	3.7	NA	12/86
385,000	NA	6,400	32	1,350	3.8	50	12/86
285,000	23.5%	4,275	26	1,144	3.1	46	3/87
244,777	24.0%	4,962	32	1,083	NA	NA	5/86
263,208	18.9%	4,973	NA	3,600	NA	NA	5/86
227,000	22.7%	5,044	13	661	3.3	58	1/87
217,400	NA	3,130	11	1,480	2.5	50	12/86
168,745	23.0%	5,647	17	440	4	48	3/87
143,000	25.8%	4,290	39	775	NA	49	6/86
90,400	22.0%	746	2	344	NA	NA	9/86
62,004	24.5%	209	12	300	3.2	49	12/86
60,787	NA	NA	6	250	NA	NA	12/86

Source: ELECTRONIC BUSINESS

FINANCE

Capital spending: Down in '86, up in '87

Computer and office equipment makers topped the list of leading capital spenders in electronics last year

By Al Furst and Linda Stallmann

Capital spending by the top 100 publicly owned electronics companies declined sharply last year. But a number of forecasters are predicting a modest rise this year and an even stronger year in 1988.

In 1986, the top 100 companies on the ELECTRONIC BUSINESS 200 doled out $13.8 billion for capital improvements. That was down considerably from the $17.1 billion total that the top 100 spent in 1985.

The downturn in spending virtually took place across the board in every industry segment of electronics, according to an analysis of all 200 companies on our annual ranking. The leading manufacturers of communications equipment spent 22.6% fewer dollars on capital equipment in 1986, compared with 1985; distributors spent 30.3% less; spending by nonsemiconductor component makers was down 22.6%; semiconductor houses lowered capital expenses 33.3%; production equipment vendors spent 22.9% less; software firms' spending declined 30.3%; office equipment makers spent 23.8% fewer dollars; minicomputer manufacturers lowered capital spending by 25%; microcomputer makers lowered expenses 27.3%; mainframe makers' spending was down 21.3%; and suppliers of military electronics spent 19.2% less money on capital improvements. The only industry segment, in fact, that showed an increase in capital spending were peripherals manufacturers. These automation-conscious companies increased capital spending by roughly 9% last year, gearing up for what is anticipated to be a return to normalcy in the personal computer industry — in 1987, 1988 and beyond.

In sheer volume, however, it was the big computer and office equipment makers that topped this year's list of leading capital spenders in electronics. The top 10 spenders, which together accounted for 69.6% of all the spending that took place last year by the top 100 companies in the industry, was headed by IBM, followed by Xerox Corp., Digital Equipment Corp., Unisys Corp., Hewlett-Packard Co., NCR Corp. and Honeywell Inc. — giants all.

In 1986, the top 100 U.S. electronics companies doled out $13.8 billion for capital improvements, down considerably from the $17.1 billion they spent in 1985

The volume of spending, however, can frequently be deceiving. IBM, for example, had revenue of $51.2 billion in fiscal 1986. So it is not all that surprising, perhaps, that the company spent a whopping $4.6 billion on capital improvements overall. What many analysts would argue is a more revealing figure is the ratio of capital expenditures to net cash flow: profits, plus depreciation after dividends.

As Jerry Wasserman, an analyst at Arthur D. Little Inc., points out: "This indicator shows how a company uses internally generated funds to support its capital expenditures on new plant and equipment. Clearly, in our increasingly competitive environment, investments in plant and equipment are critical for a company if it is to remain competitive in this ever cost-conscious industry. Our experience has been that companies that invest between 100% and 103% net cash flow after dividends are making prudent use of their funds for growth. Anything below 100% suggests that the company is being milked for profits."

On the whole, however, it appears that the industry can look forward to an upturn in capital spending this year — which is good news for capital equipment makers and for the industry in general. This forecast, analysts point out, is not just wishful thinking but is grounded in well-respected statistical analysis generated annually by the U.S. Department of Commerce. The Commerce Department makes these projections based on its survey of leading U.S. manufacturers. Historically, economists say that the surveys are fairly accurate because they reflect the spending plans of over half of monies expended each year for capital spending in the United States.

This year, the Commerce Department is predicting that manufacturers of electrical machinery, excluding computers, will see an 11% rise in capital spending, to $15.6 billion, from $14.1 billion in 1986. Meanwhile, nonelectrical machinery makers, which include computer manufacturers, are telling the Commerce Department that they plan to spend $13.07 billion this year on capital improvements, down only 4% from $13.62 billion in 1986. ☐

Top capital spenders

Fiscal 1986 figures

Rank	Company (EB 200 rank)	Capital expenditures ($ millions)	Capital expenditures as a percentage of revenue	Change from previous year	Capital expenditures to net cash flow after dividends	Total company revenue ($ millions)	Fiscal year ended
1	**IBM** (1)	$4,620.0	9.0%	-28.1%	85.4%	$51,250.0	12/86
2	**Xerox** (6)	1,032.0	11.0%	8.5%	108.2%	9,355.0	12/86
3	**GM Hughes Electronics** (4)	700.6	6.7%	-5.8%	115.4%	10,440.0	12/86
4	**Motorola** (11)	593.0	10.1%	-18.0%	103.9%	5,888.0	12/86
5	**DEC** (5)	564.2	7.4%	-1.3%	56.3%	7,590.4	6/86
6	**Unisys** (7)	553.3	7.4%	23.0%	221.1%	7,432.4	12/86
7	**Hewlett-Packard** (8)	499.0	7.0%	-21.0%	63.9%	7,102.0	10/86
8	**Texas Instruments** (13)	445.8	9.0%	-13.5%	110.0%	4,974.0	12/86
9	**NCR** (14)	360.8	7.4%	16.8%	68.7%	4,881.6	12/86
10	**Honeywell** (12)	281.4	5.2%	-42.9%	190.9%	5,378.2	12/86
11	**North American Philips** (18)	239.1	5.3%	42.2%	159.4%	4,531.6	12/86
12	**Wang Laboratories** (22)	233.6	8.8%	-54.5%	92.8%	2,642.5	6/86
13	**Pitney Bowes** (36)	208.7	10.5%	8.5%	88.0%	1,986.7	12/86
14	**Control Data** (21)	156.7	4.7%	-2.2%	-140.4%	3,346.7	12/86
15	**Intel** (48)	154.8	12.2%	-34.5%	382.6%	1,265.0	12/86
16	**AMP** (40)	151.7	7.8%	-23.6%	72.7%	1,933.1	12/86
17	**Advanced Micro Devices** (71)	136.9	23.8%	-50.4%	179.7%	576.1	3/86
18	**Data General** (46)	129.8	10.2%	-22.3%	203.8%	1,268.0	9/86
19	**Cray Research** (73)	119.2	20.0%	41.0%	65.7%	596.7	12/86
20	**National Semiconductor** (39)	116.9	7.9%	-70.8%	5,082.6%	1,478.1	5/86
21	**Harris** (29)	116.6	5.3%	-43.4%	73.4%	2,216.6	6/86
22	**Amdahl** (52)	114.5	11.8%	16.5%	100.4%	966.3	12/86
23	**Telex** (62)	101.2	14.6%	-39.1%	98.3%	695.0	3/86
24	**M/A-COM** (75)	98.0	17.0%	20.5%	294.3%	577.5	9/86
25	**Prime Computer** (58)	90.6	10.5%	22.4%	83.1%	860.2	12/86
26	**Singer** (41)	90.6	5.2%	-20.0%	79.2%	1,752.2	12/86
27	**Intergraph** (72)	78.4	12.9%	61.1%	85.8%	605.7	12/86
28	**General Instrument** (57)	73.3	9.2%	-18.5%	653.7%	794.3	2/86
29	**LSI Logic** (151)	70.5	36.3%	-14.2%	200.5%	194.3	12/86
30	**Tektronix** (44)	68.5	5.0%	-13.6%	66.2%	1,357.2	5/86
31	**Perkin-Elmer** (50)	68.5	5.3%	8.0%	72.0%	1,290.6	7/86
32	**Apple Computer** (31)	66.6	3.5%	23.3%	73.6%	1,902.0	9/86
33	**Tandem Computers** (60)	65.0	8.5%	-3.8%	60.8%	767.8	9/86
34	**Zenith Electronics** (34)	61.0	3.2%	8.0%	203.3%	1,892.1	12/86
35	**Gould** (53)	57.2	6.3%	-44.9%	68.6%	908.8	12/86
36	**Tandy** (19)	55.0	1.8%	-30.9%	21.7%	3,035.7	6/86
37	**Xidex** (84)	52.5	12.1%	152.9%	80.9%	432.3	6/86
38	**COMPAQ Computer** (69)	50.5	8.1%	38.3%	87.7%	625.2	12/86
39	**Varian Associates** (56)	50.1	5.6%	-46.8%	354.9%	891.1	9/86
40	**E-Systems** (51)	47.8	4.2%	-14.8%	67.3%	1,145.5	12/86
41	**Loral** (68)	46.2	7.0%	10.2%	65.7%	663.8	3/86
42	**Apollo Computer** (86)	41.5	10.6%	-47.0%	110.3%	391.7	12/86
43	**Molex** (91)	40.1	13.7%	-15.9%	69.6%	291.9	6/86
44	**Seagate** (66)	38.7	8.4%	39.6%	71.9%	459.8	6/86
45	**Analog Devices** (95)	36.7	11.0%	-46.6%	71.0%	334.4	10/86
46	**Sun Microsystems** (93)	36.2	17.2%	142.5%	206.4%	210.1	6/86
47	**Tracor** (76)	36.2	5.7%	-21.3%	100.9%	632.1	12/86
48	**Convergent** (101)	34.6	11.3%	76.3%	-310.1%	305.8	12/86
49	**Monolithic Memories** (140)	33.1	16.2%	-37.7%	87.8%	204.9	9/86
50	**Storage Technology** (67)	32.3	4.6%	-54.2%	27.7%	696.0	12/86

Source: ELECTRONIC BUSINESS

(continued)

Top capital spenders (continued)

Fiscal 1986 figures

Rank	Company (EB 200 rank)	Capital expenditures ($ millions)	Capital expenditures as a percentage of revenue	Change from previous year	Capital expenditures to net cash flow after dividends	Total company revenue ($ millions)	Fiscal year ended
51	**Teradyne** (100)	$30.4	9.9%	-17.8%	114.4%	$306.1	12/86
52	**CTS** (125)	27.1	11.0%	-20.7%	-156.8%	245.5	12/86
53	**Datapoint** (98)	26.3	8.1%	-60.4%	122.6%	325.2	7/86
54	**Computervision** (79)	24.8	5.0%	-33.4%	47.9%	494.7	12/86
55	**Augat** (113)	24.0	9.2%	-3.1%	-1,064.3%	260.4	12/86
56	**Avnet** (47)	22.6	1.6%	-44.6%	75.4%	1,415.6	6/86
57	**MiniScribe** (158)	21.1	11.4%	305.7%	79.0%	184.9	12/86
58	**Paradyne** (112)	20.5	7.9%	-54.5%	-165.1%	261.1	12/86
59	**Avantek** (144)	20.1	9.7%	-51.4%	71.7%	208.2	12/86
60	**DSC Communications** (102)	19.1	6.3%	-69.9%	51.7%	304.0	12/86
61	**Scientific-Atlanta** (81)	17.6	3.7%	13.7%	1,731.5%	469.1	6/86
62	**Bolt Beranek and Newman** (148)	17.3	9.7%	4.3%	88.1%	178.0	6/86
63	**Spectra-Physics** (142)	16.2	7.7%	14.1%	155.2%	210.1	9/86
64	**Western Digital** (89)	16.2	5.8%	-22.8%	47.2%	279.4	6/86
65	**Micropolis** (138)	16.1	7.6%	101.5%	60.7%	213.1	12/86
66	**General DataComm** (156)	16.0	9.0%	-28.1%	131.3%	178.0	9/86
67	**Lotus** (106)	15.5	5.5%	-27.3%	25.4%	282.9	12/86
68	**Diebold** (94)	14.9	3.6%	58.1%	54.0%	413.7	12/86
69	**Compugraphic** (92)	14.6	4.3%	-39.6%	80.5%	341.1	12/86
70	**Microsoft** (114)	14.1	7.1%	114.5%	31.3%	197.5	6/86
71	**Watkins-Johnson** (118)	13.6	5.3%	35.5%	56.7%	255.4	12/86
72	**Electrospace Systems** (161)	13.4	9.3%	36.3%	85.0%	145.0	3/86
73	**Savin** (108)	13.4	3.7%	-33.9%	78.7%	362.7	12/86
74	**Kollmorgen** (107)	12.5	3.9%	-35.1%	-170.5%	319.2	12/86
75	**Dynatech** (105)	12.4	4.8%	5.4%	43.9%	256.7	3/86
76	**Recognition Equipment** (124)	12.0	5.0%	-59.1%	59.1%	241.8	10/86
77	**UCCEL** (188)	11.8	8.3%	-18.6%	41.5%	141.6	12/86
78	**Ducommun** (87)	11.7	2.6%	-26.0%	-86.5%	455.2	12/86
79	**Applied Materials** (178)	11.5	7.7%	-10.7%	128.2%	149.3	10/86
80	**GenRad** (146)	11.5	5.6%	-70.7%	-84.6%	204.3	12/86
81	**Data Card** (175)	11.1	7.2%	10.2%	75.0%	153.6	3/86
82	**AVX** (149)	11.1	5.7%	-55.5%	83.1%	195.4	12/86
83	**SCI Systems** (80)	10.9	2.3%	24.7%	49.7%	470.2	6/86
84	**Marshall Industries** (109)	10.8	4.4%	17.4%	223.4%	244.8	5/86
85	**Applied Magnetics** (194)	10.4	8.1%	2.9%	80.8%	128.1	9/86
86	**Andrew** (147)	10.2	5.2%	-43.4%	47.6%	197.7	9/86
87	**Mentor Graphics** (164)	10.2	5.9%	-54.7%	52.3%	173.5	12/86
88	**ADC Telecommunications** (186)	10.1	7.0%	36.9%	53.3%	143.7	10/86
89	**Unitrode** (182)	9.8	6.5%	-23.1%	249.4%	149.4	1/87
90	**Dataproducts** (90)	9.1	2.6%	-58.2%	-51.6%	353.8	3/86
91	**International Rectifier** (177)	9.1	6.2%	-64.9%	186.2%	145.2	6/86
92	**Ashton-Tate** (141)	9.1	4.3%	-58.0%	21.6%	210.8	1/87
93	**Fluke** (143)	9.0	4.3%	-18.6%	41.8%	209.0	9/86
94	**Coherent** (193)	8.9	6.4%	4.8%	253.2%	138.2	9/86
95	**Wyse Technology** (131)	8.8	5.3%	57.8%	61.2%	166.4	3/86
96	**Cubic** (97)	8.6	2.6%	14.1%	139.5%	337.8	9/86
97	**Micom Systems** (154)	8.4	4.4%	-51.8%	44.1%	189.5	3/86
98	**Digital Communications** (176)	8.3	6.0%	-47.7%	33.9%	137.9	6/86
99	**Tandon** (127)	8.1	3.8%	-35.9%	-17.0%	214.1	9/86
100	**Wyle Laboratories** (134)	7.9	2.6%	118.9%	136.0%	307.0	1/87

(continued)

Source: ELECTRONIC BUSINESS

Top capital spenders by industry segments

Components

Company	Fiscal 1986 capital expenditures ($ millions)	Rank
AMP	$151.7	16
Molex	40.1	43
CTS	27.1	52
Augat	24.0	55
Kollmorgen	12.5	74
AVX	11.1	82
Total	**$266.4**	

Capital equipment

Company	Fiscal 1986 capital expenditures ($ millions)	Rank
Hewlett-Packard	$499.0	7
Tektronix	68.5	30
Perkin-Elmer	68.5	31
Varian Associates	50.1	39
Teradyne	30.4	51
Computervision	24.8	54
Spectra-Physics	16.2	63
Applied Materials	11.5	79
GenRad	11.5	80
Fluke	9.0	93
Totals	**$789.5**	

Communications

Company	Fiscal 1986 capital expenditures ($ millions)	Rank
Motorola	$593.0	4
M/A-COM	98.0	24
General Instrument	73.3	28
Paradyne	20.5	58
Avantek	20.1	59
DSC Communications	19.1	60
Scientific-Atlanta	17.6	61
Bolt Beranek and Newman	17.3	62
General DataComm	16.0	66
Dynatech	12.4	75
Andrew	10.2	86
ADC Telecommunications	10.1	88
Micom Systems	8.4	97
Digital Communications	8.3	98
Total	**$924.4**	

Computer-based systems

Company	Fiscal 1986 capital expenditures ($ millions)	Rank
Hewlett-Packard	$499.0	7
Honeywell	281.4	10
Intergraph	78.4	27
Compugraphic	14.6	69
Recognition Equipment	12.0	76
Data Card	11.1	81
Coherent	8.9	94
Total	**$905.5**	

Distributors

Company	Fiscal 1986 capital expenditures ($ millions)	Rank
Avnet	$22.6	56
Ducommun	11.7	78
Marshall Industries	10.8	84
Wyle Laboratories	7.9	100
Total	**$53.0**	

Government

Company	Fiscal 1986 capital expenditures ($ millions)	Rank
GM Hughes Electronics	$700.6	3
Motorola	593.0	4
Texas Instruments	445.8	8
Honeywell	281.4	10
Harris	116.6	21
Singer	90.6	26
E-Systems	47.8	40
Loral	46.2	41
Tracor	36.2	47
Watkins-Johnson	13.6	71
Electrospace Systems	13.4	72
Cubic	8.6	96
Total	**$2,393.8**	

Mainframes

Company	Fiscal 1986 capital expenditures ($ millions)	Rank
IBM	$4,620.0	1
Unisys	553.3	6
NCR	360.8	9
Control Data	156.7	14
Cray Research	119.2	19
Amdahl	114.5	22
Total	**$5,924.4**	

Microcomputers

Company	Fiscal 1986 capital expenditures ($ millions)	Rank
IBM	$4,620.0	1
Apple Computer	66.6	32
Tandy	55.0	36
COMPAQ Computer	50.5	38
SCI Systems	10.9	83
Total	**$4,803.0**	

Minicomputers

Company	Fiscal 1986 capital expenditures ($ millions)	Rank
IBM	$4,620.0	1
DEC	564.2	5
Hewlett-Packard	499.0	7
Data General	129.8	18
Telex	101.2	23
Prime Computer	90.6	25
Tandem Computers	65.0	33
Gould	57.2	35
Apollo Computer	41.5	42
Sun Microsystems	36.2	46
Convergent Technologies	34.6	48
Total	**$6,239.3**	

Office equipment

Company	Fiscal 1986 capital expenditures ($ millions)	Rank
IBM	$4,620.0	1
Xerox	1,032.0	2
NCR	360.8	9
Wang Laboratories	233.6	12
Pitney Bowes	208.7	13
Harris	116.6	21
Datapoint	26.3	53
Diebold	14.9	68
Savin	13.4	73
Total	**$6,626.2**	

Peripherals

Company	Fiscal 1986 capital expenditures ($ millions)	Rank
Xidex	$52.5	37
Seagate Technology	38.7	44
Storage Technology	32.3	50
MiniScribe	21.1	57
Micropolis	16.1	65
Applied Magnetics	10.4	85
Dataproducts	9.1	90
Wyse Technology	8.8	95
Tandon	8.1	99
Total	**$197.0**	

Semiconductors

Company	Fiscal 1986 capital expenditures ($ millions)	Rank
Motorola	$593.0	4
Texas Instruments	445.8	8
Intel	154.8	15
Advanced Micro Devices	136.9	17
National Semiconductor	116.9	20
LSI Logic	70.5	29
Gould	57.2	35
Analog Devices	36.7	45
Monolithic Memories	33.1	49
Western Digital	16.2	64
Unitrode	9.8	89
International Rectifier	9.1	91
Total	**$1,680.0**	

Software

Company	Fiscal 1986 capital expenditures ($ millions)	Rank
Lotus Development	$15.5	67
Microsoft	14.1	70
UCCEL	11.8	77
Mentor Graphics	10.2	87
Ashton-Tate	9.1	92
Total	**$60.7**	

Source: ELECTRONIC BUSINESS

SMALL-PACKAGE CARRIERS

Air shippers are now manufacturing partners

The rise of the air freight industry has revolutionized the way electronics companies buy and sell their products

At one time, overnight delivery for electronics and computer manufacturers was limited by the range that an executive could drive his station wagon to deliver a part that a customer demanded. Today, overnight delivery and the use of air freight has become an integral part of a company's manufacturing plans and often provides a key link in a company's just-in-time delivery strategy.

ELECTRONIC BUSINESS recently surveyed 1,000 manufacturing managers regarding their attitudes and preferences toward small-package carriers, including air shippers, ground shippers, and both air and ground shippers. We received 101 responses for a 10% response rate.

Federal Express Corp. proved to be the the most commonly used small-package carrier, followed closely by the United Parcel Service and more distantly by Emery Worldwide. Of those companies using more than one vendor, United Parcel proved to be the preferred vendor with Federal Express a close second. When those responding were asked to rate their preferred vendors, Federal Express came out on top, overall, based on ratings in price, speed of delivery, service and reliability.

With parts delivery a vital cog in the manufacturing link, price has become a secondary consideration for many manufacturing managers. "Our parcel carrier is an extension of our business and must be perceived by our customers as a 'quality' carrier," according to one survey respondent. "Dependability and customer satisfaction is our main concern," another respondent said.

Those comments were borne out in the survey findings which revealed that reliability and speed of delivery was by far a more important factor than price or variety of services offered. The electronics industry, with its heavy use of small-size, low-weight, and high-value components is particularly well-suited for small-package carriers. The survey found that components were what was typically being shipped by the respondents rather than equipment or documents.

The respondents also felt more comfortable using the major carriers rather than smaller companies or the U.S. Postal Service. ☐

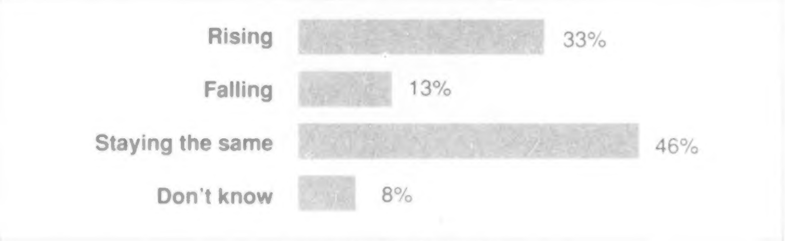
The carriers most used by the respondents

(In order of preference)

1. Federal Express
2. United Parcel Service
3. Emery Worldwide
4. DHL Worldwide Express
5. U.S. Postal Service
6. Airborne Express
7. Purolator Courier
8. Burlington Northern Air Freight
9. CF Airfreight
10. WTC Air Freight

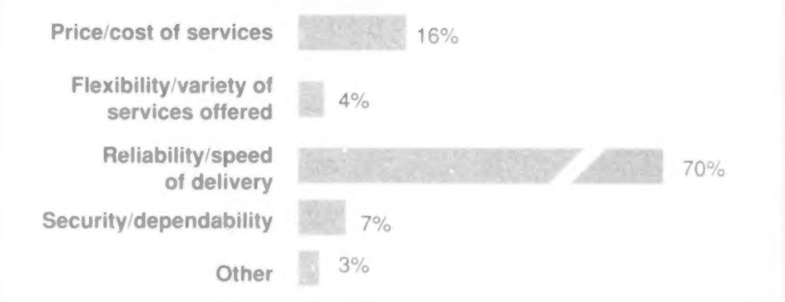
Source: ELECTRONIC BUSINESS

Are your small-package freight costs rising or falling?



Source: ELECTRONIC BUSINESS

What is the most important factor in determining which carrier to use?



Source: ELECTRONIC BUSINESS

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ATE: The best and the brightest in test

How DEC manages its $1 billion R&D budget

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The new semiconductor superstars of Silicon Valley?

MANAGING TECHNOLOGY
Simulation

Electronic Business

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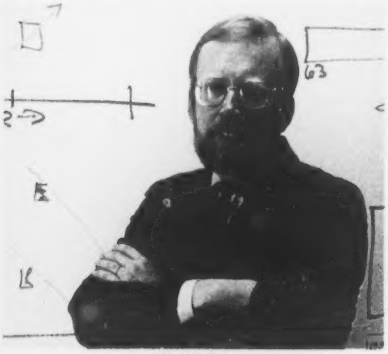
FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES



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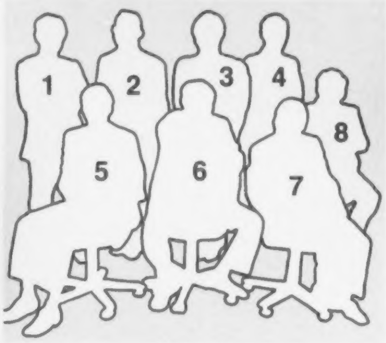

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ON THE COVER

Pictured left to right, standing, are: **1. Alex Au**, president and chief executive of Vitelic Corp.; **2. John G. Adler**, president of Adaptec Inc.; **3. Bob Swanson**, president and chief executive of Linear Technology Corp.; **4. Rodney Smith**, president and chief executive of Altera Corp. Seated are, from left: **5. Arthur J. Collmeyer**, president of Weitek Corp.; **6. Gary P. Kennedy**, president of Orbit Semiconductor Inc.; **7. Chan Desaigoudar**, chairman and chief executive of California Micro Devices Corp.; and **8. B.K. Marya**, chairman and president of Catalyst Semiconductor Inc.

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BUSINESS BAROMETER

The good old days may be back for computers

Remember when the computer industry used to outperform the economy? It's doing it again

After dropping slowly but inexorably for the second half of 1985 and all of 1986, the industrial production of computers and office machines (SIC 357) is rebounding smartly this year. Production in the second quarter already matched the level of the previous high, reached two years earlier in 1985, and was up 7% over the year-earlier level, for the second quarter of 1986, which also had the dubious distinction of being the previous low.

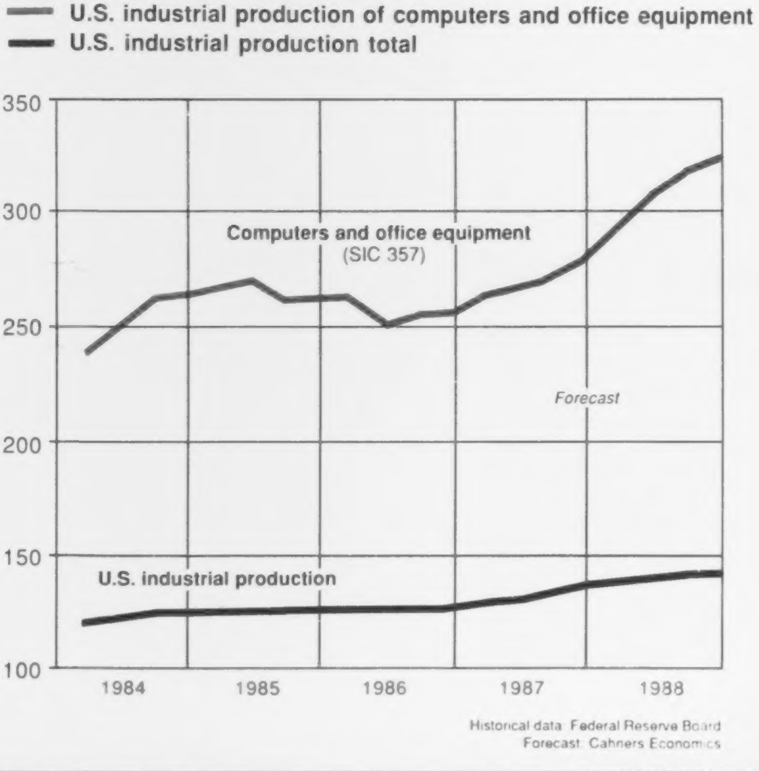
Cahners Economics forecasts that production should continue growing from here on, so much so that the second half, says economist Cheryl Patstone, may end up more than 8% ahead of the same period last year. This may signal a return to the days when the computer industry used to easily outperform the rest of the U.S. economy. Indeed, for 1987, Cahners Economics forecasts a growth of 6% for the industrial production of computers and office machines, against 4% for overall U.S. industrial production. For 1988, Patstone forecasts a 14% increase, twice the growth Cahners expects for the overall industrial production.

This is closer to the kind of performance the U.S. computer industry has been used to in the past, but it may not last much longer. In the decade from 1977 to 1986, the share represented by SIC 357 production has more than doubled, from 3% of total U.S. industrial production to 6.2%. By comparison, the share by the erstwhile all-American SIC 371 (motor vehicles and parts) has eroded in the same 10-year period from 5.4% to 4.8%. Therefore, as computers begin to account for a larger portion of industrial activity in the United States, their contribution to overall growth will increase and it will become harder for them to pull far ahead of the economy.

Even though at this writing the second-quarter revenue figures for individual companies were not yet available, it is clear from first-quarter results that the growth is coming from small systems. IBM's revenue for that period was up 5.5% over last year's quarter. As has been the case with IBM throughout the past two years, most of this increase came from sales outside the United States, which IBM fulfills usually from production plants located also abroad. Therefore, IBM's contribution to the growth of U.S. production has not been great, a fact reflected in the paltry 1% that industrial production for SIC 357 gained in the first quarter. On the other hand, Big Blue's much smaller but active PC rival Apple Computer Inc. grew by 41% in the first quarter. However, Apple's revenue amounted to only 5% of IBM's, and its production is increasingly based in the Far East. A larger contribution to U.S. industrial production may be coming from workstation manufacturers Apollo Computer and Sun Microsystems, which grew by 50% and 146%, respectively, in the first quarter. Their combined revenue amounts to less than half of Apple's, but most of this is generated by workstations produced in the United States.

One of the sources of growth, IBM hopes, is in the activity of computer manufacturers, even if many of them are competitors.

ALBERTO SOCOLOVSKY



Computers and office equipment

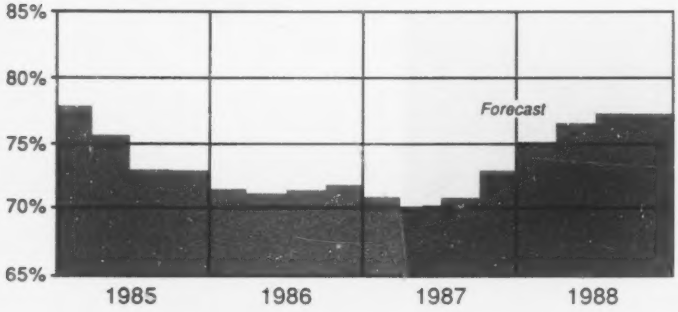
Industrial production indexes, 1977 = 100

Historical data: Federal Reserve Board
Forecast: Cahners Economics

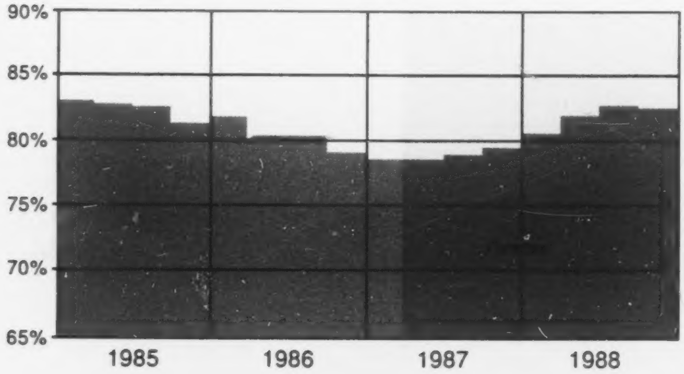
Plant utilization

Average percentage of capacity utilized per quarter

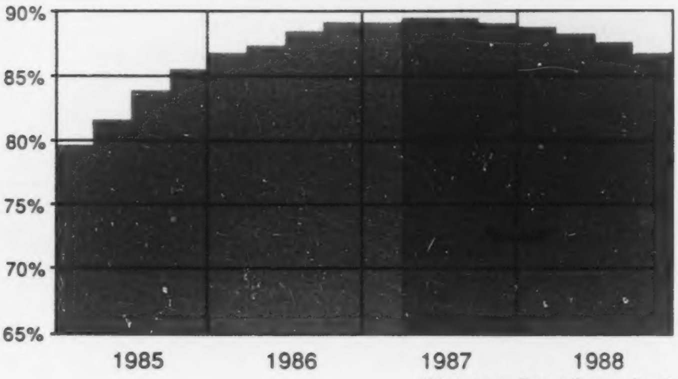
Electrical machinery (SIC 36)



Instruments (SIC 38)



Aerospace (SIC 37)



Historical data: Federal Reserve Board
Forecast: Cahners Economics

Electrical machinery

Manufacturers of electrical and electronic machinery operated at 70.8% of capacity in the first quarter, down slightly from a 71.7% rate in the previous three months. Early reports for the second quarter showed continued declines, with the utilization rate dipping below 70% for the first time since March 1983. Although consumer goods markets are sluggish right now, other segments of the industry (including electronic components and telecommunication equipment) have recently entered a growth cycle and are expected to gain momentum in late 1987 and 1988. This should cause operating rates to turn up soon, reaching 72% to 73% by this fall and 77% or higher by the end of next year.

Instruments

In the first quarter of 1987, the factory operating rate in the instrument industry was reduced by one-half of a percentage point to 78.7%. This was the 10th consecutive quarterly decline and brought the rate nearly down to the level of the 1982 low. Because the market for scientific and engineering instruments is affected by trends in U.S. capital spending, it is likely to get a boost from the higher level of planned investments in late 1987 and 1988. Production is expected to quicken after midyear with plant operating rates turning up following nearly three years of decline. Manufacturers will be using approximately 80% of capacity by the end of 1987, with the rate edging up another 3% to 4% during 1988.

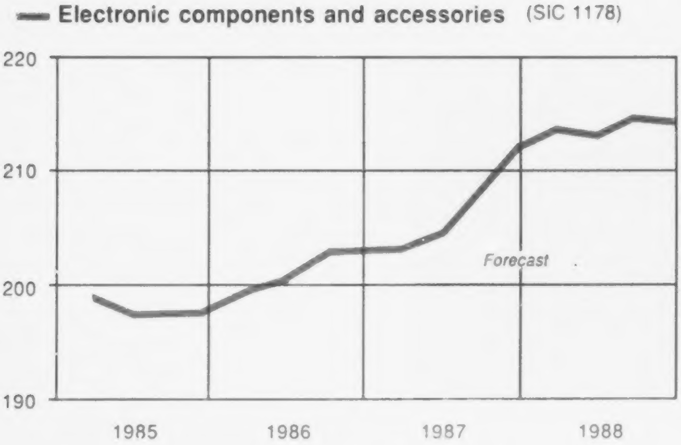
Aerospace

Capacity utilization in the aerospace equipment industries averaged 89% during the first quarter of 1987, unchanged from the level in the previous three months. Preliminary reports for the second quarter suggest that the rate will remain at 89% to 90%, more than 10 percentage points above the average for the entire 1967-1986 period. Although high backlogs will allow manufacturers to maintain about this same operating rate through year-end, the outlook for 1988 is less cheery. The recent squeeze in Department of Defense procurement authority will cause production growth to continue slowing and cause plant utilization to show a gradual decline of nearly three percentage points over the course of next year.

Producer price indexes

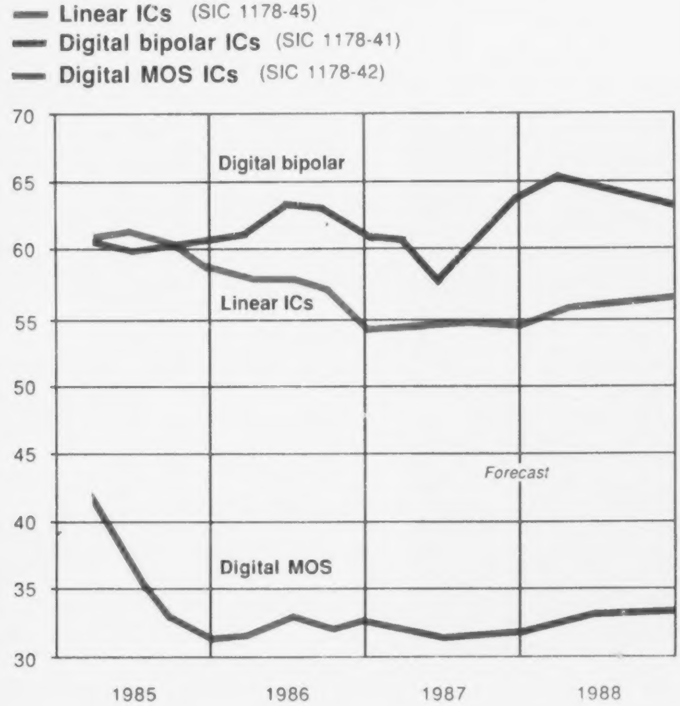
Electronic components

December 1967 = 100, quarterly averages



Integrated circuits

December 1974 = 100, quarterly averages



Historical data: Bureau of Labor Statistics
Forecast: Cahners Economics

Electronic components and accessories

Price trends within the electronic component market were somewhat mixed during the first quarter of 1987. In several product categories, including connectors and resistors, prices edged upward; in others, such as capacitors and some types of semiconductors, they dropped slightly. Industry-wide, prices decreased 0.2% in the first quarter, following an increase of 1.8% for all of 1986. Over the course of this year, as the business recovery gains steam and the U.S. rate of inflation picks up, manufacturers will gradually begin to raise prices. Prices are expected to climb 2.5% this year and 3.5% next year.

Linear ICs

Producer prices for linear ICs, which have been declining gradually since the summer of 1984, continued that trend in early 1987. First-quarter prices were down an average of 1.6% from the previous quarter and were 5.7% below the level in the first three months of 1986. While shipments are expected to register a moderate annual gain of about 12%, prices should not begin to feel corresponding upward pressures until late in the year. As a result, prices are expected to average 4.4% lower in 1987 than in 1986. Look for an overall increase of about 2.5% next year.

Digital bipolar ICs

First-quarter prices of digital bipolar ICs were down 0.8% from the prior quarter and 1.0% from the first quarter of 1986. This was the third consecutive quarterly decline and it pulled prices to the lowest level since the end of 1985. The inventory-fueled recovery that took place in early 1986 brought a temporary wave of price acceleration and the expansion that is now unfolding should result in another, more sustained rise beginning in the second half of this year. Although prices will post an overall annual decrease of 2.4%, they will be much higher at the end of 1987 than at its start. Buyers will encounter tighter supply conditions next year, with prices rising about 5.9% annually.

Digital MOS ICs

Prices of digital MOS ICs tumbled 2.4% in the first quarter of 1987 and are expected to show another decrease of perhaps half that amount, in the second quarter. Despite the softness in prices, demand has shown a solid recovery since last fall. This should translate into mild upward pressure on pricing levels during the second half of 1987 and into early 1988. Prices, which were down 10% for all of 1986, are forecast to edge 1.9% lower this year and then to bound ahead 4.1% next year.

MATERIALS

Why Japan has the corner on the IC materials market

U.S. suppliers may be producing higher quality and more consistent products, but Japan still has the lead

In a market with mature technology, where users are desperate to cut costs, one would think the recent 40% appreciation of the yen against the dollar would give a big boost to U.S. suppliers trying to win back share from the Japanese. But it hasn't helped much, so far, in electronics materials.

Few Japanese suppliers in major materials market sectors have passed through price increases yet. Indeed ,many continue to aggressively slash prices in the scramble for market share in silicon wafers, photomask blanks and leadframes.

"Japanese leadframe makers have cut prices 25% to 30% in the last year," says H. "Nephty" Carter, regional sales manager for Koltron Corp. "Customers tell me our quotes are sometimes double or triple [those of our Japanese competitors]." Koltron is now owned by Nippon Mining Company Ltd.

"My [Japanese] competitors are buying market share," similarly laments Dennis Gobbo, western regional sales manager for Hoya Electronic Corp., major supplier of photomask blanks. "They're selling it for cheaper than I can buy it [from parent company Hoya in Japan]."

Users say they've seen big improvements in quality and consistency from U.S. materials suppliers in the last couple of years, but the Japanese still have the edge.

"Domestic makers are making progress, particularly in packaging materials," says Gary Dean, vice president for materials at National Semiconductor. "They're working on adequate process control, but they still have a ways to go."

> Japanese dominance of the big sectors of the electronics materials market reflects a growing technological edge

Japanese dominance of the big sectors of the electronics materials market reflects a growing technological edge. A recent survey by the Semiconductor Research Corp. consortium's members rated the United States as having a strong lead in all materials, except ceramic packages, in 1981. Last year, however, a majority of survey participants thought the Japanese were significantly ahead in mask blanks, silicon wafers and ceramic packages, and had reached parity in resists, wet chemicals, process gases and molding compounds. Responding companies expected the U.S. to retain parity only in photoresists and process gases by 1991.

One advantage the Japanese have is practically total control of their home market. Hampered by the Japanese perception of U.S. quality problems, few U.S. materials makers have been able to crack the tight existing relationships between the big chip makers and their suppliers.

Monsanto's bid

Even giant Monsanto Co.'s giant effort hasn't come to much yet. Many Japanese industry officials predicted the leading U.S. silicon wafer maker would capture 5% to 10% of the Japanese market this year. The company had made a major investment in Japanese user service and production, and was able to offer wafers at prices reportedly 10% to 40% below its Japanese competitors at a time when chip makers were desperate to shave production costs, and also under great political pressure to buy

Worldwide materials market

Wafer fab materials
($ millions)

	1987	1988	1989
Silicon wafers	$1,265	$1,455	$1,950
Other substrates	115	133	173
Photomasks	885	1,018	1,405
Photoresists			
Negative	71	78	94
Positive	103	120	169
Wet chemicals	258	291	379
Gases	316	363	501
Deposition materials	74	83	144
Total	$3,087	$3,541	$4,815

Packaging materials
($ millions)

	1987	1988	1989
Leadframes	$380	$398	$466
Ceramic packages (metallized)	328	370	455
Thick-film pastes	206	210	231
Encapsulation resins	171	177	211
Bonding wire	173	181	211
Cerdip	156	161	186
Headers and cans	98	98	102
Seal lids	86	108	138
Hybrid substrates (active)	90	95	116
Hybrid packages	84	92	103
Die attach materials	67	75	92
Other	146	158	179
Total	$1,985	$2,123	$2,490

Source: "Electronic Materials Report"

American. But, so far, Monsanto's share of the Japanese market has risen only from about 2% to a little over 3%.

"We definitely see more interest at a top management level," says a company spokesman. "But it's not filtering down to the level of the guy who's doing the purchasing. Our goal of 10% share is probably not realistic. It's probably not realistic to expect the Japanese market to change all its practices and long-standing relationships."

Most of the major Japanese materials producers are still making money, but not much. Operating margins for the major materials producers continue to shrink. Operating earnings as a percent of sales slipped from 12% to 11% at Kyocera Corp. in the most recent fiscal year, from 7% to 6% at Nitto Denko, from 5% to 1% at Toshiba Ceramics, and from 3% to -1% at Osaka Titanium Corp. Hoya, however, managed to maintain 13% operating margins in the last two fiscal years.

A losing proposition

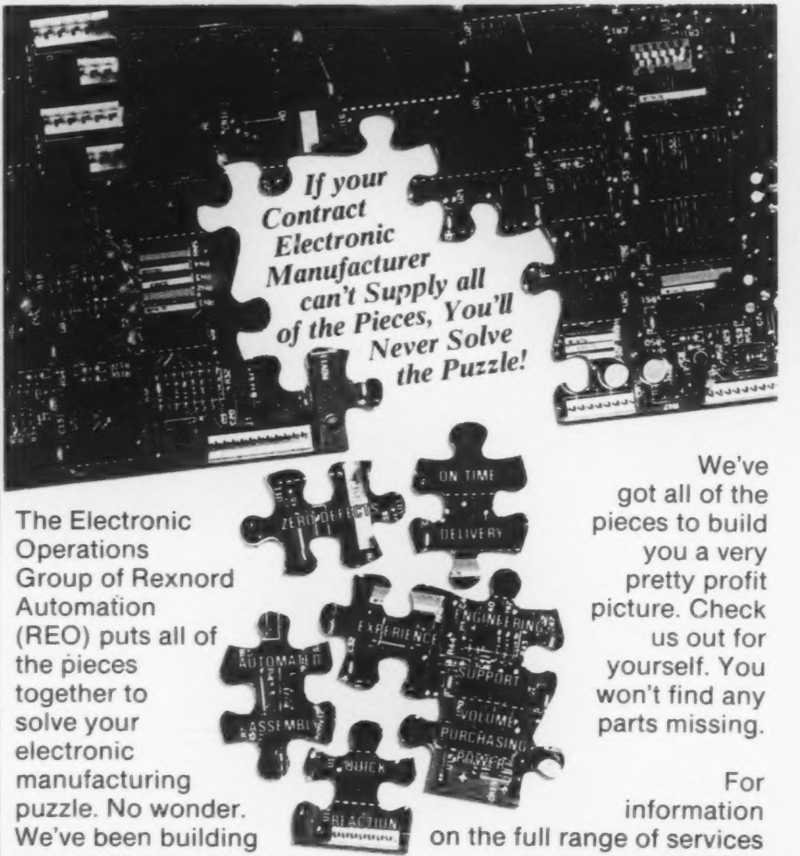
A number of Japanese materials executives admit privately that they are losing money in the United States. One, who asked not to be identified, says that his company's sales are currently much stronger in the United States than in Japan, but the company is losing so much money here that it is considering pulling back and refocusing more of its attention on Japan.

The relatively small and undiversified materials makers are resorting to some drastic cost-cutting steps — like laying off workers. Leadframe maker Mitsui High-Tec cut its permanent workforce by 15% through voluntary resignations and also trimmed 267 part-time workers. OTC reportedly laid off 150 workers, or 10% of the workforce, from its production subsidiary. Kyocera says that its margins improved in the second half of the last fiscal year when it trimmed its workforce by 800, about 6%, by attrition.

Paradoxically, the high yen is likely to drive prices and margins down even further in the near future, as a horde of struggling old-line chemical and metals companies look to electronics materials as their salvation. Kawasaki Steel's expanded NBK, Nippon Steel and Showa Denko are all now sampling silicon wafers to Japanese users, while Toyo Soda holds off production until the market picks up. Kobe Steel and Nisshin Steel are entering the leadframe fray. Kawasaki Steel is pushing aluminum nitride substrates for integrated circuits. Sumitomo Electric Industries is entering the wire-bonding business. Thirteen chemical companies, at last count, had come up with new photoresists using their polymer technology.

"There's going to be huge competition," says Daniel Rose, a Los Altos, Calif., materials consultant and publisher of "Electronic Materials Report." Rose says, "Monsanto and Wacker don't even know what they're in for."

PAULA DOE



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MANAGEMENT

SEMICONDUCTORS

The upstart start-ups

As the semiconductor industry hit new lows, the number of start-ups hit new highs. But is there life after niches?

BY VALERIE RICE

THE CLASS OF 1987: (seated, left to right) Weitek's Arthur Collmeyer, Technology's Robert Swanson, Catalyst's B.K. Marya and California

Liane Enkelis

In the Valley, during the most prolonged semiconductor slump that the industry has witnessed, the seeds of the new U.S. chip business were sown. Led by industry veterans often espousing such semiconductor heresies as fabless operations and Spartan surroundings, these companies are beating the start-up survival odds and are making the chip giants rethink their business strategies.

Approximately 130 semiconductor start-ups were formed between 1978 and 1986 and most of them have beaten the odds that half would fail in two years. This surprising survival rate built on the will to succeed is probably the most outstanding quality of this new breed of companies, born during a slump but bred to weather the long term.

Other qualities surface as well. These companies run lean, have aggressive marketing and pricing, and are headed by street-wise executives. All of the company leaders have spent years at large companies; many have done a start-up before. The start-ups are growing so fast that Dataquest Inc. predicts that they will account for nearly $2 billion in semiconductor revenue by the end of this year, up from only $20 million in 1980. But this new breed also has patience — no "short-term growth — damn the consequences" philosophy for these companies. Says Catalyst Semiconductor Inc. president and founder B.K. Marya, "It's all in the attitude. If you want to become a Hewlett-Packard or an IBM Corp., you can't do it instantly. You have to sweat it out."

Of all the start-ups formed over the last nine or 10 years, 75% of them are based in San Jose, California's Silicon Valley region, with the remaining 25% spread out over 12 other national regions, according to a study based at the California State University of San Jose on "New Ventures in the Semiconductor Industry." The study, sponsored by the U.S. Department of Commerce, focuses on the factors of IC start-up success and failure.

Ten Silicon Valley-based companies — Adaptec Inc., Altera Corp., California Micro Devices Corp., Catalyst, Chips and Technologies Inc., Cypress Semiconductor Corp., Linear Technology Corp., Orbit Semiconductor Inc., Vitelic Corp. and Weitek Corp. — are topflight examples of the new breed. All are currently profitable, all had 1986 sales under $55 million, all are convinced they won't repeat the missteps of their ancestors. These 10 start-ups represent, but don't encompass, the new breed of chip companies. There are many other start-ups that could have been included.

The new semiconductor companies often appear to base their business plans on the premise that those who went before were wrong. Start-up executives, describing

bit's Gary Kennedy and Altera's Rodney Smith; (standing, left to right) Vitelic's Alex Au, Adaptec's John Adler, Linear
cro Devices' Chan Desaigoudar

their company origins as "moribund," and "stifling," are determined to create a company where decisions could be made quickly and response times kept to a minimum. And based on the numbers, that strategy seems to be working.

Acid test

One acid test, certainly, is how customers feel about "new breed" products. Ford Motor Co.'s purchasing manager Eugene Greenstein, who admits a distinct reluctance to patronize companies without their own fab facilities, will concede that Ford does use Linear Technology as a supplier because he says that "they supply us with a part we couldn't get anywhere else. It is a quality part and it is very unique." Linear does have its own fabrication facility unlike many of its start-up brethren.

"Focused" is another word that is common to start-ups. These companies exist because they found the chink in the armor of big companies that tried to be a source of one-stop shopping for their customers. This philosophy left a lot of small markets out of the picture, ones that were certainly big enough to attract the attention of small, eager start-ups.

San Jose-based Adaptec, for example, was founded to do just input/output bus boards for personal computers (currently one-third of the firm's business is in chips). These boards are a very narrowly focused area, marketing vice president Jeff Miller says, but one that has stood its ground for the company. "Understanding the silicon was not enough for us," he says. "We had to understand the drives and the systems as well. We supply a niche market, but it is a niche market with our potential customers being everyone who has a disk drive."

Another key element to start-up success, and one that is common among all of the companies, is the size of the target market. For a small company to take on the world, it had better do so at a level that does not rile the big companies. New companies often choose markets too small for large American or Japanese companies to care about and can thus stay under their "radar" and avoid detection.

San Jose-based Weitek did just that. According to marketing vice president John Rizzo, the company went after that section of the digital signal processing market not dominated by market leader Texas Instruments. Now Weitek predicts that their DSP market segment will grow to between $300 million and $500 million in 1987, and it will continue that growth reaching $1.5 billion by the early 1990s. Weitek, by being there first, by being small enough to react to the market, and without the cost pressures associated with a fab, should be able to keep ahead of the market, Rizzo contends. "You've got to keep subdividing the market. Make the niches smaller and smaller. A $1.5 billion dollar market is not one product, it's 100 products," Rizzo says.

GARY KENNEDY, (left) president of Orbit Semiconductor; **ARTHUR COLLMEYER,** (center) president of of Weitek; and **B.K. MARYA,** (right) president and chairman of Catalyst Semiconductor

Liane Enkelis

Start-up companies also differentiate themselves on the basis of research and development spending. According to one report, the semiconductor industry spends an average of 10.7% of sales on R&D, compared with industry as a whole which only spends 3.1% of sales on R&D. According to the New Ventures study, start-ups (both with and without a fab) have a ratio of R&D dollars to sales of 167% in the first year; 212% in the second year; and 174.75% in the third year.

One common theme among most of these companies is the "custom" nature of their products. Reflecting become more vocal and demanding about service and support, and are constantly in the process of reducing their suppliers, small semiconductor companies with customized solutions are in a strong position to reach key, high-margin business from customers demanding solutions.

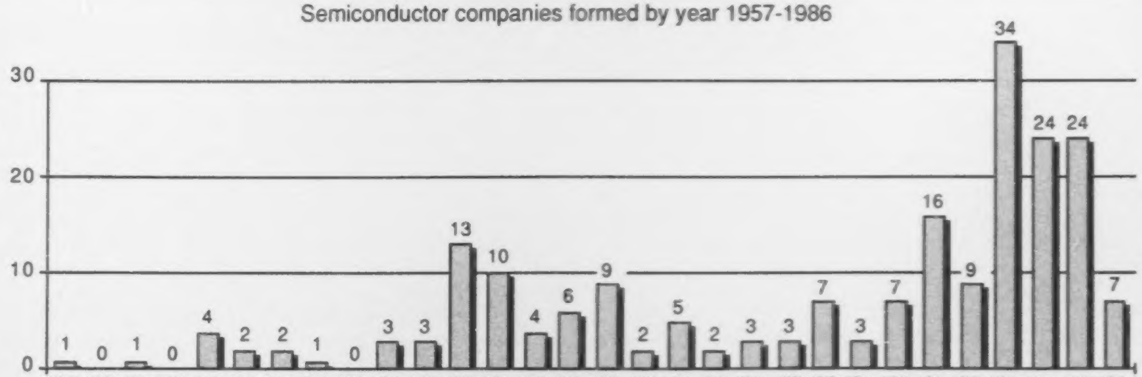
Says Vitelic marketing vice president Gary Ater: "What pleased the customer in the past pleases him no more today. They are breaking up package-type purchasing [one-stop shopping], and they are demanding uniqueness for their products. Big companies take so much longer to create that uniqueness. The new concept today is small."

To characterize his company's philosophy, Catalyst's Marya calls his products "soft chips," because they are malleable. Catalyst will alter anything to suit a customer's need, Marya claims, and by using words like "soft chips" he hopes to get that message across clearly.

"We do everything for everybody," says Cypress Semiconductor president and founder T.J. Rogers. "We are totally flexible on engineering execution. We do all our manufacturing on any conceivable packaging configuration. Most companies our size have two or three products or even five. We have 74 base products, but over 1,000 variants of those products."

Another key element of start-up success is playing to a company's

The increased start-up pace



17 Started 11 Acquired 2 Closed (12% closed)	52 Started 19 Acquired 19 Closed (37% closed)	134 Started 10 Acquired 7 Closed (12% closed)

Source: Dataquest Inc.

strengths. For Cypress that meant going after the leading edge in speed and flexibility in high-performance CMOS. For Altera, it meant leveraging their skills and knowledge in the erasable programmable logic device (EPLD) market. For Vitelic, based in San Jose, it was a question of selling their flexibility and strengths in the custom memory area. Chips and Technologies made its mark when it entered the market with an IBM PC AT chip set, really giving the clone market the push it needed to take off and bringing its own growth rate to 76% between 1986 and 1987.

The exception to these rules is Linear Technology. According to Linear president Robert Swanson, not being a digital company breaks all the rules. Unlike other start-ups that can't and don't want to be full service shops, Linear must offer a full slate of analog solutions, and that includes having a fabrication facility of its own. Swanson describes the analog market as a broad sweep of products, customers and needs. "We have to be a broad line supplier," he says. As a result, Linear has a portfolio of 1,200 products which Swanson says "brings a lot of niches together."

But that strategy has worked for the company, which is showing 70% growth over last year, 20% pre-tax margins, and over $1 million in profits for fiscal 1986. "For every $1 in capital investment, we increase sales by $5," Swanson claims.

Orbit Semiconductor also is in a category of its own. Set against both full service houses and the marketing/design houses, Orbit makes a very good living doing foundry work, particularly for low-volume, specialty products.

Orbit president and cofounder Gary Kennedy says that his niche is in "guaranteed turnaround. We have the fastest in the industry," he claims. "The difference is we sell no products. Most every other company has products or service design centers for custom products. We do high-reliability parts in a number of processes. We also have one of the highest prices, but we charge based on value. If we are late, it is 30% less," he says.

Four new breeds

The new breed of start-ups fall into one of four categories, three of which are very different from the traditional semiconductor manufacturing mold.

The first type is a traditional process-driven semiconductor company like a Cypress or a Linear Technology. Both companies have fab capacity, both are trying to push the limits of process technology, and both are full service companies.

JOHN ADLER, (left) president of Adaptec; **ROBERT SWANSON,** (center) president and CEO of Linear Technology; and **ALEX AU,** president and CEO of Vitelic

Liane Enkelis

For some customers, this is still the only type of semiconductor company that will be taken seriously. Ford Motor does not purchase parts from small start-up companies, particularly if they do not have a fab. Says Greenstein; "Who's responsible for quality if there's a problem? We want to deal directly with the manufacturer."

Called value-added distributors or designers (VADs), the second type of semiconductor company is market driven, rather than process driven. They do not have their own fab, but rather use foundry space in other companies' fabs to generate product. Altera, Catalyst, California Micro Devices, Chips and Technologies, Vitelic and Weitek all fall in that category. All of these companies focus on custom or semicustom solutions-oriented products, and all describe themselves as flexible.

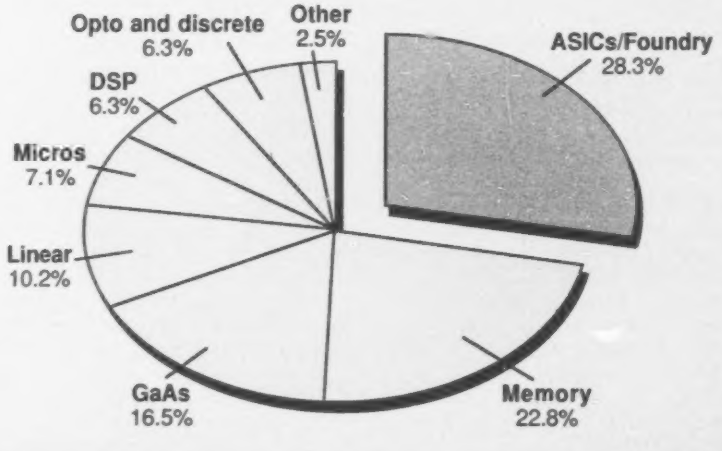
This type is the fastest growing start-up category, and may continue to be for some time, as bottom-line conscious managers struggle to leverage a good product idea with a minimum of investment.

Mountain View, California-based Sun Microsystems Inc. purchasing manager Scott Metcalfe says his company believes in supporting young start-ups, particularly this kind of value-added operation. But, he says, "We worry about the lack of fab capacity. We go to the foundry company directly and negotiate our ability to stay in the queue. We want to make sure they have enough capacity for us in cyclical times."

To illustrate just how sincere Sun's commitment to start-ups is, the com-

Most start-ups are in the ASIC arena

Semiconductor start-ups by market segment



Source: Dataquest Inc.

pany recently signed an agreement with Cypress Semiconductor to jointly develop a high-performance CMOS reduced instruction set computing (RISC) architecture microprocessor.

The third type is the purely service company that does no design but just offers foundry for small volume, high-complexity runs. Orbit Semiconductor is an example of this.

The final type is the vertically integrated company that sells chips and a system or system product, and models itself on the best of the Japanese firms for success. Adaptec, which sells I/O chips and I/O boards using both its own and others' chips, is a vertically integrated company.

Real men have fabs

"You are not a real semiconductor company without a fab," asserts Cypress' Rogers, who has his own fab.

Yet, over two-thirds of these companies lack a fab facility to call their own. Over time, according to the New Ventures study, many of these start-ups build their own. But many companies are staunchly seeking alternate sources.

The biggest advantage Vitelic has over its larger competition, says president Alex Au, is its low overhead and high flexibility because it is not a slave to a fab.

Others agree. "You build a fab and spend your whole life paying for it," says Catalyst's Marya. Catalyst will ultimately have a high reliability, low volume fab, Marya says, but the company will likely never have a high volume fab.

Chips and Technologies president and founder Gordon Campbell never wants a fab, but realizes that ultimately he may have to bite the bullet. The same is true for companies like Altera and Weitek.

But for the time being, these companies are utilizing the high degree of excess fab capacity that exists worldwide. Market research firm In-Stat Inc. estimates that worldwide, fabs are running at between 50% and 65% capacity this year, and much of this capacity exists offshore.

Not surprisingly, then, many of these companies have offshore foundry agreements with European, Japanese, Korean or Taiwanese companies. A relatively few companies have foundry arrangements with U.S. companies, a fact which puzzles and angers some industry pundits who worry about the export of technology offshore.

Campbell points out, however, that small U.S. start-ups often don't have any choice but to make a deal with the Japanese because other U.S. companies are less than receptive. "U.S. semiconductor manufacturers have not gone out of their way to offer subcontracted work," he says. "They are typically not very receptive. The Japanese are very receptive. The only reason they are receptive is that it is

The big guys: In a state of flux

Large companies have really taken it on the chin lately, thanks to the success of the new breed of small semiconductor start-ups.

It is no longer fashionable to be big.

Some of these start-ups, flush with their success, have thrown the gauntlet down, challenging large companies to change the way they do business in order to become more proactive in the market. And, small companies have also alleged that the large semiconductor companies should stop whining about unfair competition and demanding protectionism, and start cleaning their own houses. After all, some of the small companies are beating these guys at their own games.

But are they? There is certainly some evidence that big companies are getting more aggressive and more entrepreneurial in the United States. Consider National Semiconductor's recent deal with Lattice Semiconductor, Beaverton, Ore. That is just one of several deals National has, says semiconductor division executive vice president James Smaha, and the company is looking for as many of these as make sense.

Intel Corp., Santa Clara, Calif., also has several little "in-house spin-offs" under way, says chairman Gordon Moore, and there are funds that exist to continue doing separate spin-offs as necessary.

Motorola Inc. is also rumored to be spinning off a separate group to work on futuristic technology.

This should not be construed as a whole-scale effort to plunge into unknown markets, however. At National, Smaha looks for partners, companies that need what National has to offer, either foundry, money, market access, or any of the three, therefore allowing National to get first rights to leading-edge technology processes without having to invest heavily in them. "Partnerships are a key part of our basic strategy," Smaha says. "We are prepared to do that with big and small companies, on and offshore. Partnerships must be a win/win."

Big companies are getting more aggressive and more entrepreneurial

At Intel, Moore says that the company has changed over the past years, becoming more market driven and aware of smaller market niches that might have been ignored in the past. In fact, the company is developing several "opportunities" internally, in separate little groups. Two of those opportunities, in fact, are actually housed in separate buildings, in an effort to create more of an entrepreneurial spirit among the engineers. (One of those projects is the PC add-in board, the Above Board, and one is a supercomputer project based on the Hypercube.)

The problem with being a large company today, Moore explains, is that "we have our hands full with the business we have. We have a lot of existing business to tend to. When we are pressured in our existing business areas, it's hard to send our best guys out to do something unless we're sure."

But for the future, National's Smaha warns that there are too many companies in business today, and the market, he says, cannot support 200 semiconductor companies by the year 1990. The start-up momentum will slow down, he hopes, and maybe the pressure he has been feeling will recede. "Five to seven years ago," he says, "this used to be a fun job." □

easier to sell to Japanese companies. The same is true in Europe. It is also cheaper to manufacture."

And by using the advanced process technology available in Japan, Campbell says, a small company can leverage its product base signficantly. "We can stay on the leading edge for free," he says. "We can use whatever technology is best: CMOS, bipolar, BiCMOS. A little company like ours couldn't afford to do all that. There are strong arguments in favor of subcontractors."

Dataquest's Semiconductor Industry Service associate director Mel Thomsen asserts, however, that U.S. companies may have good reason for limiting their inrvolvement with start-ups. Most of those companies, Thomsen theorizes, may already be at work on the same ideas that the start-ups are trying to push, only it takes them much longer to bring them to market.

What about strategic alliance? Clearly the buzzword of the 1980s, strategic alliances would seem to be the answer to a small company's needs. Alliances can provide more than just foundry and can include deals that bring capital, support, new technology and market access, as well as having the added benefit of giving potential customers some reassurance.

Everybody is doing a deal these days, and it does seem as if the Japanese are coming out on top. According to a recent Dataquest study, of the 127 start-ups Dataquest identified in the 1977 to 1985 period, 43 companies have over 70 agreements with Asian companies.

What worries many U.S. players is that small companies, looking for short-term gains, are bargaining the store away. One company with no offshore alliances, the highly profitable Adaptec, says that instead of a sense of nationalism, the company chose to have more control over quality — something only possible with agreements with locally owned and operated companies.

Altera also has an onshore relationship with Intel Corp., Santa Clara, Calif., for EPLD parts. This relationship, says Altera president Rodney Smith, adds credibility to his company, and is a "technology exchange agreement" with no foundry. Altera also recently signed a technology exchange agreement with Cypress for the development of high performance, user-configurable logic products.

RODNEY SMITH, (left) president and CEO of Altera; and **CHAN DESAIGOUDAR,** (right) chairman and CEO of California Micro Devices

Liane Enkelis

In terms of general alliances, data from the New Venture study indicates that start-ups have 1.3 alliances their first year, dwindling to 0.8 alliances by the fifth year. This indicates that the issue is not the number of alliances but one key alliance, New Venture study codirector Claudia Bird Schoonhoven says. These strategic alliances do not include foundry agreements.

"Management by mavericks," as one executive puts it, has given each start-up company a character that is unique to itself. At Catalyst Semiconductor, time and openness are everything to president and founder Marya. "The CEO's challenge is to keep an open office," he says. "You need more hands-on management." Concerning time: "Time is more important than money to us," he says. "Running out of time is as bad as running out of money."

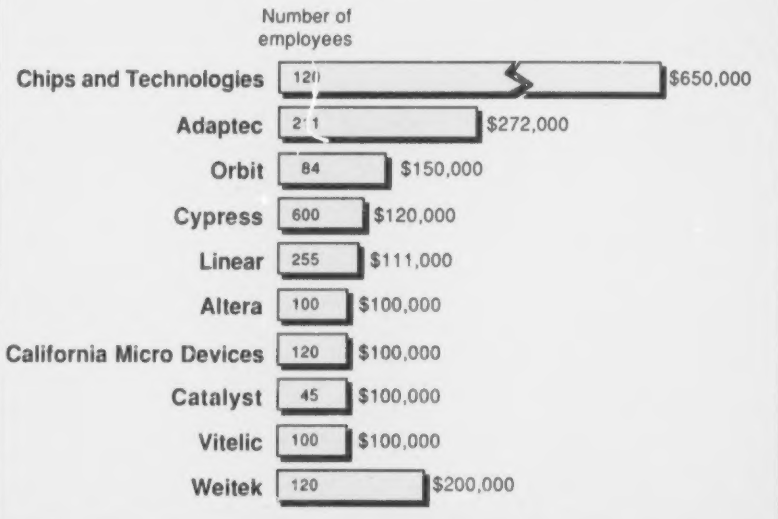
Altera's Smith says that "technology outstrips demand. Twenty percent of semiconductor start-ups fail. The trick is to establish a foothold in a growing market and look for a flanking move. You are smart to build a barrier and protect yourself so that no one can get at you," Smith says.

"Experience is a two-edged sword," says Weitek president Arthur Collmeyer. "A lot of what you learned about managing a company doesn't apply; it has a shelf life. Experience alone can be a liability. We don't do a semiconductor company the way other people did. Now more companies are doing it the way we do it — without a fab." But, Collmeyer stresses, "the ingredients for success don't change."

The outspoken Rogers of Cypress has a unique theory of management. Rogers claims he "borrows" the best

New breed revenue per employee

Revenue per employee (Calendar 1986)



Source: Electronic Business

ideas from each of the big semiconductor companies in order to make his company a reflection of all the best parts of the industry. For example, Rogers says that Advanced Micro Devices Inc. is known as a company with good marketing and service, and he has hired people away from AMD to fill those roles at Cypress.

A strange success

The success of these companies may seem strange, given the tumultuous time surrounding their founding. But, according to Dataquest's Thomsen, the best time to start a new business is in a downturn. During this period of time, when product is being developed and strategies are being solidified, everyone else in the industry is worrying about his bottom line, and not looking at new markets.

And venture capital has certainly flourished during the period of 1978 through 1986. According to Dataquest, venture capital available for all high technology firms in 1983 was $3.4 billion, which then dropped to $3.2 billion in 1984 and $2.6 billion in 1985. Stan Bruderle, a Dataquest vice president, says that there were around 35 semiconductor start-ups in 1983 competing for a share of that money, and 25 in 1984. For comparison, Bruderle says that 1986 was a relatively slow start-up year, with only six companies, but those six shared $73.6 million in initial funding.

Venture capital backing can give a company a strong competitive edge in the market

"What drove the start-up situation was changes in the laws of the U.S. which set up research and development investment tax credits and general ITCs," Bruderle says. "With a limited R&D partnership the investors get a tax advantage or a tax shelter if they invest in new areas. The resulting venture capital was huge, looking for places to be spent."

But according to the New Ventures study, a surprisingly small percentage of start-ups has venture capital funding. In fact, only 50% of semiconductor start-ups have venture capital in their first year, growing to 59% of the total companies by their fourth year in existence (for the period 1978 to 1983), codirector Schoonhoven says.

The relatively small percentage of companies with venture capital probably means some reluctance on the part of executives to give the company away. On the other hand, venture capital backing can give a company a strong competitive edge in the market.

The security of venture capital can also create problems, cautions Campbell. That helping hand of venture capital can give a company a sense of false security, and eliminate the need to watch the costs. Without venture capital, every penny that goes out the door is watched, says California Micro Devices chairman and founder Chan Desaigoudar, who did not have any venture investments.

But for the typical company

LSI's Corrigan: The founding father of the new breed

Many have speculated why Wilfred Corrigan, chairman of Fairchild Corp. during the late 1970s, had to leave the company in order to pursue the application specific integrated circuits (ASICs) business by forming a new company, LSI Logic Corp.

Corrigan, who could certainly be considered the founder of the new breed of companies, says in a nutshell that once a company's culture is formed, it is very difficult to run counter to it, with either product or management ideas, even if you're the chairman.

"You have to go back to the seed," Corrigan says. "Once a company has been in existence for a period of time, it has a culture, and it is difficult to change that."

According to Corrigan, it is difficult to do something revolutionary within a large company. Evolutionary products are relatively easy within a large company, Corrigan claims, but doing something nonevolutionary is nearly impossible. He cites the example of Intel's microprocessor as a revolutionary development that only Motorola was ever able to match. Companies like National and Texas Instruments, he says, have tried but have never succeeded.

"Getting into a totally new area requires a major effort and a lot of focus on the part of a company," he explains. "Typically for a large company it is difficult to critically fund that development when the industry as a whole is facing bad times. From 1981 to 1987 there was only one good period — the latter half of 1983 and all of 1984. The whole rest of the time the majors were under severe financial stress. Their willingness to spend money to start new enterprises wasn't there."

"Getting into a totally new arena requires a major effort and a lot of focus on the part of the company"
Wilfred Corrigan of LSI Logic

"At LSI Logic in early 1982 we were burning $300,000 per month at the bottom line. In a large company, we probably would have been shut down or trimmed back because the market wasn't that obvious."

Corrigan likens his experiences at the start-up LSI with being an early, New World explorer. He calls it the Columbus effect. "You know there's something great out there on the other side of the horizon, but the boards of directors are not great believers in the Columbus effect. That's what is meant by *venture* capital."

Smaller companies, then, set sail and have nowhere to go but forward, Corrigan says. And for LSI, the small size and the close relationship to the market made it easy to change course when necessary. "We started as an ECL gate array company, and in less than three months, we discovered that our business plan was OK, but we had the wrong product and the wrong customer base. We had to come up with a totally new product line. Visualize what would happen to a division manager in a large company if he were to change course 12 weeks out. That could only happen in a small company." ☐

Liane Enkelis

(started between 1978 and 1983) with venture capital, it could raise $6.7 million during its first year, says New Venture's Schoonhoven.

The breed's future

Does the new breed have staying power? They certainly seem to, and a look at the New Ventures data supports this. Says Schoonhoven: "The recession has gone on so long that those who were going to die or be acquired by 1986 have done so. Resources continue to support these companies for a much longer period of time."

> Despite a somewhat charmed existence, growth into the next stages may be difficult for some of these companies, particularly those without a fab facility

Yet, despite a somewhat charmed existence, growth into the next stages may be difficult for some of these companies, particularly those without a fab facility. "Calling these companies the new breed is just falling into the rhetoric," admonishes L.F. Rothschild analyst Paul Johnson. "It's fine to say that they are new and different, but to imply that they won't face the same problems in growth every other company has is very naive. These companies are good but no miracle."

"It's not hard to get to $20 million in sales from nothing," Dataquest's Thomsen says. "The hard part is growing to $100 million and over. What then?"

Rothschild's Johnson says that he hasn't seen that many companies grow above $500 million in this industry. Taking Cypress as an example, he says that for Cypress to grow to $1 billion, it would have to increase its size by 25% every year for 10 years, or to put it in other terms, roughly outgrow the industry by two times every year.

Dataquest's Thomsen says the issue really is how a company can finance its growth. Growth is achievable by all of these companies, he said, with or without a fab, but at a certain point, a company must come up with the money to reinvest in order to grow.

That is one reason that right now, Cypress, flush with money from public offerings, has one of the top-line high performance CMOS fabs in the industry, certainly better than most of the major companies, Thomsen says. This is also one reason why Fairchild has had growth problems in the past, he adds: insufficient funds to support needed growth.

And of course, the issue of a fab is seen by many as vital for future growth.

"It appears possible to grow without a fab," says Montgomery Securities general partner Daniel Klesken. "If it's possible, it is the preferred way financially to grow," he says. "The disadvantage is that you don't have total control of your destiny. The factory owner may put you second, third, or fourth on his list."

According to Klesken, a company like Chips and Technologies must ultimately "have some fab under its control," something of which Campbell appears cognizant.

Thomsen also says that a company can't grow without volume, and volume is not achievable without a fab facility of some sort. Low-volume business is good for the short term, but in the long run, a company must achieve high volumes at some level in order to really grow, he says.

Klesken, who feels these companies "have a great future ahead of them," says that future survival is simply a matter of "doing what they've already done. Finding new markets and going out and serving them." ☐

The return of the metal desk

"Look," he said, pointing with pride, "I have a metal desk."

As it happened, that was Chips and Technologies Inc. president and founder Gordon Campbell speaking; but it could have been almost anyone of the founders of the new breed of start-ups.

It would appear that the new austerity is here to stay, bringing with it a group of people who believe that "less is more" at least as it applies to office furniture.

And despite the seeming frivolity of this issue, there is an underlying seriousness here. Most semiconductor start-ups (all types of start-ups, for that matter) fail because of anticipatory spending. It seems that the new breed has taken heed of that, with a vengeance.

"We have metal desks," Catalyst Semiconductor Inc. president and founder B.K. Marya says. "We have all used office furniture, and only 50% of our people have phones on their desks."

"The first time you do a start-up you have a lot of big company concepts," Campbell says. "In the second start-up you do, you don't do anything that doesn't contribute to your bottom line or your profits. The last place I am going to be putting money is into facilities or anything else like that."

Cypress Semiconductor Corp.'s president and founder T.J. Rogers gets a little defensive on the subject of desks. Rogers, who has a large oak desk in his office, is very quick to point out that only he and three other of his vice presidents have wooden desks, and only because "we have such heavy public contact." Otherwise, as he is quick to prove, the rest of the company sits in cubicals with metal desks. ☐

RESEARCH & DEVELOPMENT

The top R&D spenders in the electronics industry

R&D spending rose 9.5% last year, led by chip makers and semiconductor-dependent tester companies

By Al Furst and Linda Stallmann

In 1986, Advanced Micro Devices Inc. led the electronics industry in research and development, investing $183.9 million in R&D, or roughly 31.9% of sales.

In an industry where 8% R&D spending is considered the norm, AMD's commitment to new technology strikes some industry experts as incredible. But W. Jerry Sanders, who founded the Sunnyvale, Calif., integrated circuit maker 22 years ago, says he sees nothing wrong with investing in the future, even if it means going into the red.

"If R&D were only 8% of sales, we would have been profitable," Sanders maintains. "But, because our R&D is close to 30% of sales, we lost money." Even so, Sanders says, AMD had no choice.

"If we have evaluated the market for our new products correctly, we have to maintain our level of investment in research and development," he says. "We could keep a tight rein on our capital spending and would not need more cash. But, if we don't invest in R&D, we'd be just relegated to a niche supplier."

Although Sanders may be a little more zealous than most of his counterparts in enthusiasm for new product development, he's not alone in his thinking. Four of the top 10 R&D spenders in the electronics industry last year were chip makers, including Monolithic Memories Inc., a company that AMD is in the process of acquiring. The other two chip makers which made the top 10 in 1986 were Intel Corp., which was No. 2, and National Semiconductor Corp. at No. 8.

Also underscoring the R&D-intensive nature of the microelectronics industry is that two big chip-tester companies, GenRad Inc. and Teradyne Inc., were also represented in the top 10 of our list, as well.

This dedication to research also spilled over into other areas of the electronics industry. As Bernard M. Gordon, chairman and president of 14th-ranked Analogic Corp., points out, "The rate of technological change is occurring at a rate faster than most people can absorb it," forcing many companies to think that they have to invest heavily in engineering, even if, in some cases, productivity suffers.

In all, the 100 biggest research and development spenders in the electronics industry invested $12.9 billion in R&D last year, 9.5% more than the $11.7 billion that these same 100 companies spent in 1985. On a company-by-company basis, this reflects an average 8% investment in R&D by the top 100 in 1986, versus a 7.7% average in 1985.

There are, of course, other ways of looking at the data. ELECTRONIC BUSINESS magazine's list of the top R&D spenders is based on an exclusive analysis of the top 100 publicly owned U.S. electronics companies — that is, companies which derived at least 70% of sales from electronics — with over $100 million in sales. However, in addition to looking at the leaders, ranked by R&D as a percentage of sales, it may be also worthwhile to measure how much these companies spent on R&D last year versus the year earlier.

Five companies in the top 100 more than doubled their R&D budgets last year — including workstation vendor Sun Microsystems Inc., electronic warfare specialist Loral Corp., and three disk-drive makers — Maxtor Corp., Micropolis Corp. and MiniScribe Corp.

In terms of sheer R&D spending, IBM spends more on its research and development projects than most companies have sales. ☐

Top R&D spenders in dollars

Fiscal 1986 figures

Company	R&D expenditures ($ millions)	R&D as a percentage of revenue	R&D rank
IBM	$3,975.0	7.8%	58
Hewlett-Packard	824.0	11.6%	17
DEC	814.1	10.7%	29
Xerox	650.0	6.9%	66
Motorola	492.0	8.4%	52
Unisys	440.8	5.9%	74
GM Hughes Electronics	408.1	3.9%	98
Texas Instruments	406.0	8.2%	53
NCR	320.7	6.6%	69
Control Data	313.9	9.4%	37

Source: ELECTRONIC BUSINESS

Top R&D spenders

Rank			Fiscal 1986 figures				
1986	1985	Company (EB 200 rank)	R&D as a percentage of revenue	R&D expenditures ($ millions)	Change from previous year	Total company revenue ($ millions)	Fiscal year ended
1	6	**Advanced Micro Devices** (71)	31.9%	$183.9	+12.0%	$576.1	3/86
2	8	**Intel** (48)	18.0%	228.3	+16.9%	1,265.0	12/86
3	2	**GenRad** (146)	17.6%	35.9	-20.7%	204.3	12/86
4	14	**Monolithic Memories** (140)	17.2%	35.2	+44.1%	204.9	9/86
5	13	**Teradyne** (100)	16.6%	50.8	+9.4%	306.1	12/86
6	4	**Applied Materials** (178)	16.5%	24.6	-21.9%	149.3	10/86
7	3	**DSC Communications** (102)	15.2%	46.2	-20.0%	304.0	12/86
8	20	**National Semiconductor** (39)	15.0%	222.4	+8.7%	1,478.1	5/86
9	16	**Cray Research** (73)	14.7%	87.7	+78.3%	596.7	12/86
10	15	**Tektronix** (44)	14.6%	198.2	+3.7%	1,357.2	5/86
11	-	**Sun Microsystems** (93)	14.6%	30.6	+101.7%	210.1	6/86
12	18	**Analog Devices** (95)	13.5%	45.3	+18.9%	334.4	10/86
13	-	**Applied Magnetics** (194)	13.2%	17.0	+5.7%	128.1	9/86
14	12	**Analogic** (170)	12.4%	18.4	-0.1%	148.2	7/86
15	7	**Amdahl** (52)	12.3%	119.2	-11.6%	966.3	12/86
16	22	**Avantek** (144)	12.2%	25.4	+20.7%	208.2	12/86
17	26	**Hewlett-Packard** (8)	11.6%	824.0	+20.3%	7,102.0	10/86
18	29	**Fluke** (143)	11.5%	24.1	+7.7%	209.0	9/86
19	-	**Lotus Development** (106)	11.5%	32.5	+53.5%	282.9	12/86
20	9	**Apollo** (86)	11.4%	44.7	+7.5%	391.7	12/86
21	-	**Digital Communications** (176)	11.3%	15.6	+30.1%	137.9	6/86
22	35	**Compugraphic** (92)	11.3%	38.5	-0.4%	341.1	12/86
23	28	**Data General** (46)	11.3%	143.1	+11.4%	1,268.0	9/86
24	19	**Tandem Computers** (60)	11.3%	86.6	+21.0%	767.8	9/86
25	30	**LSI Logic** (151)	11.1%	21.6	+49.5%	194.3	12/86
26	39	**General DataComm** (156)	11.0%	19.6	+15.7%	178.0	9/86
27	31	**Gould** (53)	10.8%	97.9	-32.0%	908.8	12/86
28	62	**Convergent Technologies** (101)	10.7%	32.8	+15.8%	305.8	12/86
29	23	**DEC** (5)	10.7%	814.1	+13.5%	7,590.4	6/86
30	17	**Coherent** (193)	10.7%	14.8	-8.3%	138.2	9/86
31	25	**Prime Computer** (58)	10.7%	91.9	+12.4%	860.2	12/86
32	-	**Microsoft** (114)	10.4%	20.5	+20.0%	197.5	6/86
33	24	**Mentor Graphics** (164)	9.7%	16.8	+15.5%	173.5	12/86
34	27	**Medtronic** (85)	9.6%	38.5	-2.1%	402.8	4/86
35	36	**Intergraph** (72)	9.5%	57.7	+13.9%	605.7	12/86
36	11	**Computervision** (79)	9.4%	46.7	-24.2%	494.7	12/86
37	44	**Control Data** (21)	9.4%	313.9	-0.7%	3,346.7	12/86
38	56	**Gerber Scientific** (139)	9.3%	17.9	+5.9%	191.8	4/86
39	-	**Ashton-Tate** (141)	9.2%	19.5	+72.5%	210.8	1/87
40	53	**Cipher Data** (160)	9.2%	15.1	+14.7%	163.0	6/86
41	57	**Varian** (56)	9.2%	82.3	+12.3%	891.1	9/86
42	-	**ADC Telecommunications** (186)	9.0%	13.0	+9.6%	143.7	10/86
43	-	**UCCEL** (188)	9.0%	12.7	-18.7%	141.6	12/86
44	21	**ISC Systems** (173)	9.0%	14.9	-12.8%	166.1	6/86
45	34	**Storage Technology** (67)	8.9%	62.1	-4.9%	696.0	12/86
46	65	**Western Digital** (89)	8.8%	24.7	+98.6%	279.4	6/86
47	32	**AMP** (40)	8.8%	170.0	+6.3%	1,933.1	12/86
48	73	**Dataproducts** (90)	8.8%	31.0	+0.6%	353.8	3/86
49	63	**Dynatech** (105)	8.6%	22.1	+50.8%	256.7	3/86
50	42	**Spectra-Physics** (142)	8.5%	17.9	+7.4%	210.1	9/8

Source: ELECTRONIC BUSINESS

(continued)

Top R&D spenders (continued)

Fiscal 1986 figures

Rank 1986	Rank 1985	Company (EB 200 rank)	R&D as a percentage of revenue	R&D expenditures ($ millions)	Change from previous year	Total company revenue ($ millions)	Fiscal year ended
51	33	**Micom** (154)	8.4%	$15.9	-15.4%	$189.5	3/86
52	46	**Motorola** (11)	8.4%	492.0	+6.0%	5,888.0	12/86
53	49	**Texas Instruments** (13)	8.2%	406.0	+1.0%	4,974.0	12/86
54	59	**Unitrode** (182)	8.2%	12.2	-2.0%	149.4	1/87
55	55	**Perkin-Elmer** (50)	8.1%	105.0	+6.1%	1,290.6	7/86
56	64	**Altos** (192)	8.0%	10.8	+21.7%	134.2	6/86
57	92	**Tandon** (127)	7.9%	16.8	+36.7%	214.1	9/86
58	68	**IBM** (1)	7.8%	3,975.0	+15.0%	51,250.0	12/86
59	54	**Wang Laboratories** (22)	7.7%	202.8	+12.0%	2,642.5	6/86
60	48	**TIE/communications** (103)	7.7%	22.9	-12.9%	298.2	12/86
61	37	**Paradyne** (112)	7.4%	19.5	-18.6%	261.1	12/86
62	79	**Veeco Instruments** (166)	7.4%	12.3	+39.6%	167.8	9/86
63	47	**Measurex** (152)	7.3%	14.1	-2.6%	192.7	11/86
64	-	**Maxtor** (184)	7.0%	5.9	+100.0%	85.2	3/86
65	43	**Datapoint** (98)	7.0%	22.6	-49.4%	325.2	7/86
66	67	**Xerox** (6)	6.9%	650.0	+7.8%	9,355.0	12/86
67	61	**Andrew** (147)	6.7%	13.3	-16.6%	197.7	9/86
68	98	**Apple Computer** (31)	6.7%	127.8	+76.2%	1,902.0	9/86
69	66	**NCR** (14)	6.6%	320.7	+7.2%	4,881.6	12/86
70	70	**Augat** (113)	6.4%	16.7	-1.8%	260.4	12/86
71	74	**Watkins-Johnson** (118)	6.4%	16.3	+9.2%	255.4	12/86
72	84	**International Rectifier** (177)	6.4%	9.2	+24.3%	145.2	6/86
73	52	**Diasonics** (136)	6.3%	13.7	+12.3%	217.1	12/86
74	-	**Unisys** (7)	5.9%	440.8	+54.6%	7,432.4	12/86
75	88	**M/A-COM** (75)	5.9%	34.0	-20.7%	577.5	9/86
76	71	**Scientific-Atlanta** (81)	5.9%	27.6	-4.8%	469.1	6/86
77	72	**Molex** (91)	5.9%	17.1	+3.0%	291.9	6/86
78	-	**Data Card** (175)	5.8%	9.0	+29.0%	153.6	3/86
79	-	**Atari** (115)	5.6%	14.5	+53.4%	258.1	12/86
80	80	**Aydin** (196)	5.5%	7.6	-0.1%	136.8	12/86
81	94	**Telex** (62)	5.5%	38.3	+55.5%	695.0	3/86
82	-	**Wyse** (131)	5.4%	8.9	+97.3%	166.4	3/86
83	89	**Harris** (29)	5.3%	117.9	+1.9%	2,216.6	6/86
84	78	**Zenith** (34)	5.3%	99.7	+3.9%	1,892.1	12/86
85	-	**Micropolis** (138)	5.2%	11.2	+122.7%	213.1	12/86
86	85	**Decision Industries** (150)	5.2%	10.2	+7.9%	195.1	11/86
87	60	**Kollmorgen** (107)	5.2%	16.6	-27.9%	319.2	12/86
88	86	**General Instrument** (57)	5.2%	41.2	-21.5%	794.3	2/86
89	100	**AST Research** (168)	4.9%	8.4	+67.5%	172.3	6/86
90	-	**Bolt Beranek and Newman** (148)	4.8%	8.6	+50.8%	178.0	6/86
91	75	**Recognition Equipment** (124)	4.8%	11.6	+18.0%	241.8	10/86
92	-	**Loral** (68)	4.7%	30.9	+101.4%	663.8	3/86
93	-	**MiniScribe** (158)	4.6%	8.6	+103.5%	184.9	12/86
94	69	**Honeywell** (12)	4.6%	246.7	-45.3%	5,378.2	12/86
95	-	**Intelligent Systems** (187)	4.6%	5.7	-2.2%	125.5	3/86
96	-	**COMPAQ Computer** (69)	4.3%	26.6	+66.3%	625.2	12/86
97	41	**Seagate** (66)	4.1%	18.9	-2.2%	459.8	6/86
98	-	**GM Hughes Electronics** (4)	3.9%	408.1	+3.9%	10,440.0	12/86
99	-	**Genicom** (174)	3.9%	6.1	+2.3%	157.5	12/86
100	-	**Sun Electric** (169)	3.2%	5.8	+15.8%	177.0	10/86

Source: ELECTRONIC BUSINESS

(continued)

Top R&D spenders by industry segments

Semiconductors

Company	Fiscal 1986 R&D expenditures ($ millions)	Fiscal 1986 R&D as a percentage of revenue
Motorola	$492.0	8.4%
Texas Instruments	406.0	8.2%
Intel	228.3	18.0%
National Semiconductor	222.4	15.0%
Advanced Micro Devices	183.9	31.9%
Gould	97.9	10.8%
Analog Devices	45.3	13.5%
General Instrument	41.2	5.2%
Monolithic Memories	35.2	17.2%
Western Digital	24.7	8.8%
LSI Logic	21.6	11.1%
Unitrode	12.2	8.2%
International Rectifier	9.2	6.4%
Total	**$1,819.7**	**10.6%**

Components

Company	Fiscal 1986 R&D expenditures ($ millions)	Fiscal 1986 R&D as a percentage of revenue
AMP	$170.0	8.8%
Molex	17.1	5.9%
Augat	16.7	6.4%
Kollmorgen	16.6	5.2%
Total	**$220.4**	**7.9%**

Capital equipment

Company	Fiscal 1986 R&D expenditures ($ millions)	Fiscal 1986 R&D as a percentage of revenue
Hewlett-Packard	$824.0	11.6%
Tektronix	198.2	14.6%
Perkin-Elmer	105.0	8.1%
Varian	82.3	9.2%
Teradyne	50.8	16.6%
Computervision	46.7	9.4%
GenRad	35.9	17.6%
Applied Materials	24.6	16.5%
Fluke	24.1	11.5%
Gerber Scientific	17.9	9.3%
Spectra-Physics	17.9	8.5%
Total	**$1,427.4**	**11.5%**

Computer-based systems

Company	Fiscal 1986 R&D expenditures ($ millions)	Fiscal 1986 R&D as a percentage of revenue
Hewlett-Packard	$824.0	11.6%
Honeywell	246.7	4.6%
Intergraph	57.7	9.5%
Compugraphic	38.5	11.3%
ISC Systems	14.9	9.0%
Coherent	14.8	10.7%
Measurex	14.1	7.3%
Recognition Equipment	11.6	4.8%
Data Card	9.0	5.8%
Sun Electric	5.8	3.2%
Total	**$1,237.1**	**8.5%**

Microcomputers

Company	Fiscal 1986 R&D expenditures ($ millions)	Fiscal 1986 R&D as a percentage of revenue
IBM	$3,975.0	7.8%
Apple	127.8	6.7%
COMPAQ	26.6	4.3%
Atari	14.5	5.6%
Altos	10.8	8.0%
Total	**$4,154.6**	**7.7%**

Minicomputers

Company	Fiscal 1986 R&D expenditures ($ millions)	Fiscal 1986 R&D as a percentage of revenue
IBM	$3,975.0	7.8%
Hewlett-Packard	824.0	11.6%
DEC	814.1	10.7%
Data General	143.1	11.3%
Gould	97.9	10.8%
Prime Computer	91.9	10.7%
Tandem Computers	86.6	11.3%
Apollo Computer	44.7	11.4%
Telex	38.3	5.5%
Convergent	32.8	10.7%
Sun Microsystems	30.6	14.6%
Analogic	18.4	12.4%
Total	**$6,197.5**	**8.7%**

Mainframes

Company	Fiscal 1986 R&D expenditures ($ millions)	Fiscal 1986 R&D as a percentage of revenue
IBM	$3,975.0	7.8%
Unisys	440.8	5.9%
NCR	320.7	6.6%
Control Data	313.9	9.4%
Amdahl	119.2	12.3%
Cray	87.7	14.7%
Total	**$5,257.3**	**7.7%**

Peripherals

Company	Fiscal 1986 R&D expenditures ($ millions)	Fiscal 1986 R&D as a percentage of revenue
Storage Technology	$62.1	8.9%
Dataproducts	31.0	8.8%
Seagate	18.9	4.1%
Applied Magnetics	17.0	13.2%
Tandon	16.8	7.9%
Cipher Data	15.1	9.2%
Micropolis	11.2	5.2%
Decision Industries	10.2	5.2%
Wyse	8.9	5.4%
MiniScribe	8.6	4.6%
AST Research	8.4	4.9%
Genicom	6.1	3.9%
Maxtor	5.9	7.0%
Intelligent Systems	5.7	4.6%
Total	**$226.0**	**6.8%**

Communications

Company	Fiscal 1986 R&D expenditures ($ millions)	Fiscal 1986 R&D as a percentage of revenue
Motorola	$492.0	8.4%
DSC Communications	46.2	15.2%
General Instrument	41.2	5.2%
M/A-COM	34.0	5.9%
Scientific-Atlanta	27.6	5.9%
Avantek	25.4	12.2%
TIE/communications	22.9	7.7%
Dynatech	22.1	8.6%
General DataComm	19.6	11.0%
Paradyne	19.5	7.4%
Micom	15.9	8.4%
Digital Communications	15.6	11.3%
Andrew	13.3	6.7%
ADC Telecommunications	13.0	9.0%
Bolt Beranek and Newman	8.6	4.8%
Aydin	7.6	5.5%
Total	**$824.3**	**8.1%**

Government

Company	Fiscal 1986 R&D expenditures ($ millions)	Fiscal 1986 R&D as a percentage of revenue
Motorola	$492.0	8.4%
GM Hughes Electronics	408.1	3.9%
Texas Instruments	406.0	8.2%
Honeywell	246.7	4.6%
Harris	117.9	5.3%
Loral	30.9	4.7%
Watkins-Johnson	16.3	6.4%
Total	**$1,717.9**	**5.8%**

Office equipment

Company	Fiscal 1986 R&D expenditures ($ millions)	Fiscal 1986 R&D as a percentage of revenue
IBM	$3,975.0	7.8%
Xerox	650.0	6.9%
NCR	320.7	6.6%
Wang Laboratories	202.8	7.7%
Harris	117.9	5.3%
Datapoint	22.6	7.0%
Total	**$5,289.1**	**7.5%**

Software

Company	Fiscal 1986 R&D expenditures ($ millions)	Fiscal 1986 R&D as a percentage of revenue
Lotus Development	$32.5	11.5%
Microsoft	20.5	10.4%
Ashton-Tate	19.5	9.2%
Mentor Graphics	16.8	9.7%
UCCEL	12.7	9.0%
Total	**$102.0**	**10.1%**

Total may not add due to rounding

Source: ELECTRONIC BUSINESS

AUTOMATIC TEST EQUIPMENT

As the chip industry goes, so goes test

ATE vendors are optimistic that sales will continue to build as the U.S. semiconductor industry strengthens

By David Card

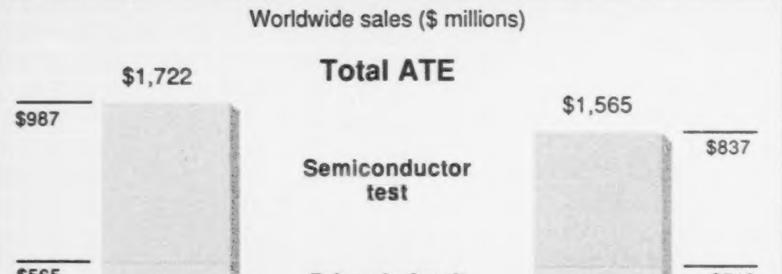
After bottoming out of a two-year slump last year, the world market for automatic test equipment is expected to achieve positive growth in 1987. San Jose, Calif., market research firm Prime Data Inc. forecasts 8% growth this year — to over $1.7 billion in sales.

"The dilemma is that the market has gone down for the past two years in a row, so 8% growth is all relative," mourns Prime Data analyst Kenneth Neff. Only a few years ago, sales of ATE to test components and printed circuit boards were growing at a 30% annual clip.

"Our end markets, mired in a slump that began in 1985, have continued to work off the excess capacity they had built up in the heady days of '83 and '84," explains William Thurston, president of ATE maker GenRad Inc. in Concord, Mass. Looking at Prime Data's forecasts, Thurston says his firm expects a rebound but "we're a little more conservative [than Prime Data] — once bitten, twice shy."

Prime Data's Neff, however, says that the general economy has started to pick up. "The Commerce Department has said that there will be 3% growth in capital expenditures this year where it was about flat last year," Neff says. "There are perceptions that the general economic environment is improving." Improving, yes, agrees analyst Stephen Balog of Prudential-Bache Securities Inc. in New York City, but not so fast as to push up ATE sales.

Worldwide ATE sales slumped in 1986



Source: Prime Data Inc.

Balog is still waiting. "It doesn't look like, right now, business is booming," he says. "In terms of capital spending, the electronics OEMs certainly haven't turned it on again. It's not clear that business is back by any means."

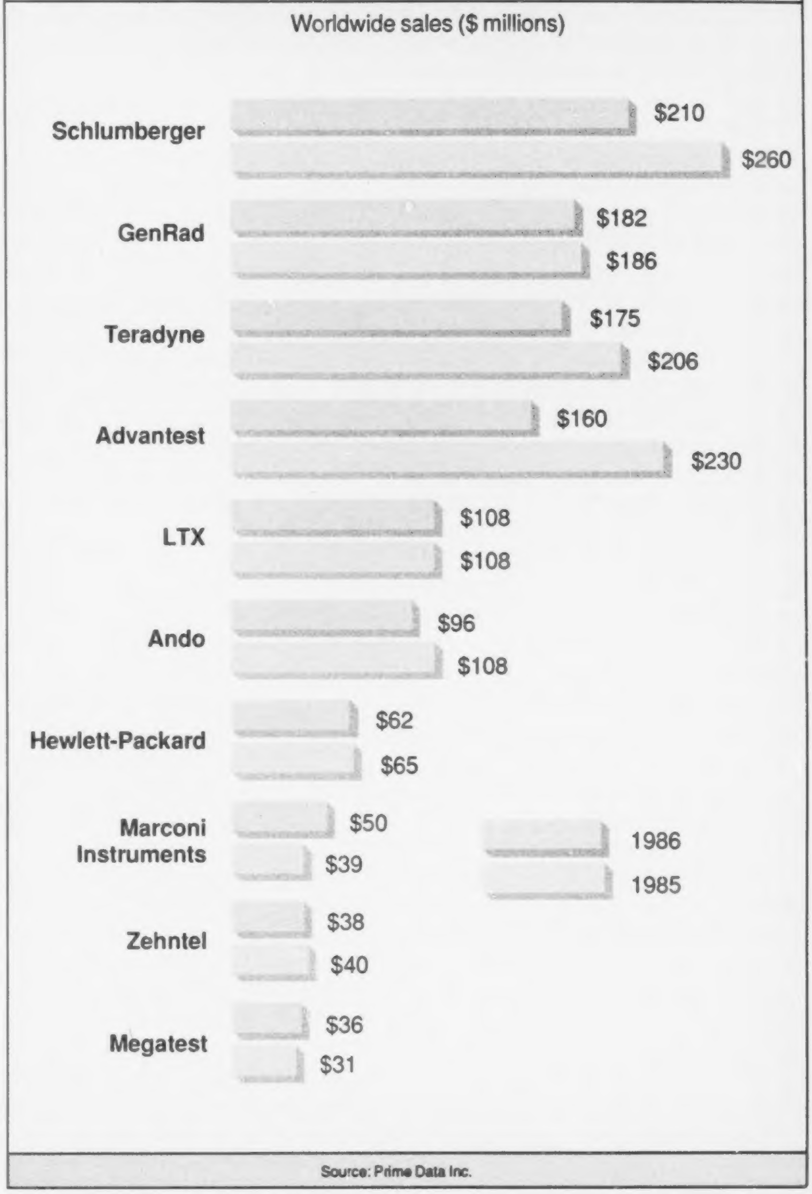
However, some vendors disagree. James Mulady, director of United States sales and marketing for the Japanese chip test supplier Ando Corp., says "there's no question" that Ando's 1987 sales will be up "15%, maybe 20%. And we look for '88 to be another 15% to 20% — maybe even better," Mulady says.

A good year would also benefit Advantest Corp., the Japanese company that Prime Data ranks No. 1 in semiconductor ATE. Sales went down over 30% last year by Prime Data's reckoning. This does not faze Frederick Bihler, president of Advantest's U.S. operations in Lincolnshire, Ill. A new, ultra high-end tester "should help pick up business," Bihler says. "We made our bet on it."

Even a usually gloomy Alexander d'Arbeloff, president of Boston tester maker Teradyne Inc., is cheering up. "It's a lot more encouraging," d'Arbeloff says. "The semiconductor industry has been up. The word on the West Coast is that people are a lot more optimistic." He thinks 1988 will be a good year. "I believe it. I think the question is: Is there going to be a recovery? If the general economy is even reasonable, the computer business will come out of its shell. There has been confidence building in that industry and that's what has been weak."

"When you have a two-year recession instead of one that lasts six

Top 10 manufacturers of automatic test equipment



Source: Prime Data Inc.

months, you clean up your balance sheet and idle capacity," says Daniel Pujol, vice president and general manager of Schlumberger Ltd.'s Sentry component tester division in San Jose. That could apply as equally to Sentry as to its customers, Pujol says. After some consolidations of manufacturing — something nearly every ATE company did over the past two years — Sentry has its manufacturing capacity in line with the market, says Pujol. Any time the chip makers are ready to start buying equipment, he says, Sentry is ready to comply. "Generally, when their factories are at around 85% capacity, the semiconductor companies will be investing in capital equipment," he says. "Today, they're at 75% to 80%."

Prime Data's Neff says that for the past couple of years, the only chip-testing equipment that anybody has been buying has been the high-end, engineering machines. "What's encouraging now," Neff says, "is that some production buys are going through."

Meanwhile, chip tester LTX Corp. of Westwood, Mass., would like to see a little more action on the production-buying front. LTX's Trillium subsidiary has been doing quite well selling into engineering applications with its high-end digital tester, but LTX's core linear test business has dragged the company down. "There is a recovery going on, you know," says LTX president Graham Miller. "Korea and Taiwan are doing particularly well," he adds. "The [high value of the] yen encouraged their investment in consumer products."

Even so, the strength of the yen, and to a lesser degree, European currencies, has played havoc with Prime Data's annual ATE sales rankings, complains Neff. "The reality is somewhat skewed," Neff explains. "The perception is that the foreigners did better than the American companies." European business did hold up, he says, much to the benefit of companies like Marconi Instruments Ltd. Still, Neff cautions that if Adventest's results had been reported in dollars rather than in yen, they would have looked much worse.

U.S. companies also reported good sales in Europe. Another firm market was military business. Last year it was a stronghold and ATE executives think it should continue that way. "Military business is not booming, but it's OK," says Teradyne's d'Arbeloff.

Both Sentry and Teradyne have new memory testers, but it seems few customers are in the market for them — at least for the time being. Teradyne, realizing the memory chip business had migrated Eastward, has been trying hard for two years to sell its model J937 into Japan. So far, no luck. "We're still holding out," d'Arbeloff says, "We're close enough to selling and it is promising enough that I can say that."

Sentry's Pujol can conceive of two scenarios that would result in a real resurgence of the U.S. memory tester business in five years. One scenario, he says, presupposes that the proposed consortium Sematech is a tremendous success, and U.S. chip makers regain memory dominance. The other has the Japanese losing the memory chip business to South Korea. "As everyone knows," Pujol says, "the Koreans and the Japanese are not in love. They [the Korean companies] would much rather buy an American product.

"Or else," Pujol says, "everything can remain as it is, and the business remains Japan's." He calls that a realistic, but grim, prospect. "We are still in business in Japan, but we are not in the market," he says. Sentry only

Automatic test equipment: A graphic look at

DESIGN

CAD for ICs

Calma
Daisy
Seiko

$206 million

CAE

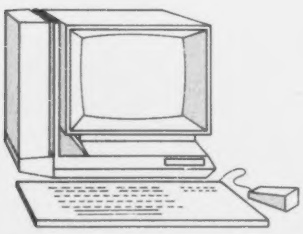
Mentor
Daisy
Valid

$481 million

CAD for PCBs

Racal-Redac
Computervision
Scientific Calculations

$472 million



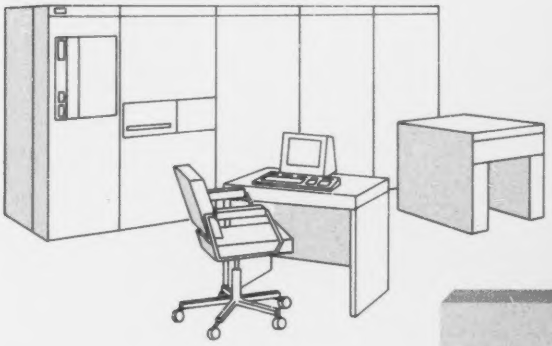
CHIP PRODUCTION

Engineering and production ATE for components

Advantest
Sentry

$707 million

(Includes memory and linear ICs)



Equipment category

Market leaders

1986 worldwide sales

Total 1986 worldwide ATE sales: $1,565 million

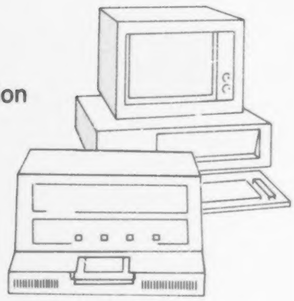
the 1986 market

BOARD PRODUCTION

Incoming inspection

Sentry
GenRad

$130 million



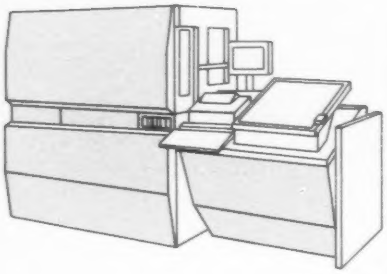
Bare board inspection

(Sales included in Interconnection and verification analysis)

Production ATE for PCBs

GenRad
FACTRON
Teradyne

$467 milion

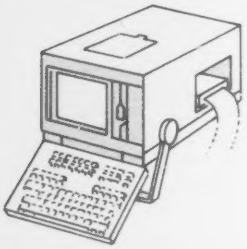


Interconnection and verification analysis

DIT-MCO
Mania
Everett/Charles

$186 million

PRODUCT TEST AND SERVICE



Service and field test

GenRad
Fluke

$75 million

Source: Prime Data Inc.

INTERNATIONAL

China: Poised at an economic crossroads

The Communist Party Congress in October is expected to give some indication of which direction China plans to take

By Al Furst

In two months, the Chinese Communist Party will gather in Beijing to chart the nation's economic plan for the next five years. The October Party Congress will be watched closely by the American electronics industry to determine whether or not China will continue to experiment with free-enterprise management techniques.

In recent months, uncertainty about that country's future economic direction has caused many U.S. companies to reconsider the depth of their commitment to the People's Republic of China (PRC). If China decides to go back to the Russian model of a highly centralized economy, similar to what it did in the 1950s, many multinationals would have a hard time justifying increased investment.

Most observers, however, now predict that the faction of so-called reformers, under Deng Xiaoping, will reassert their authority over the ideologues, or hard-liners, at the Congress, making it easier for Americans to do business in China. Newly elected leaders, it is hoped, will press ahead with needed reforms to eliminate red tape, price gouging, excessive taxation and other problems confronting foreigners. U.S. corporations are also hopeful that the Chinese will step up purchases of computer and electronic equipment, even if it means borrowing money from Western banks.

"I'm not a political scientist, I'm just an American businessman," says Louis Woo, the Macao-born business development manager for Apple Computer International. "But from what I've seen of the countryside in China and the cities, from the people, from their standard of living and living quarters, the amount of money they spend and what they spend it on, life has changed dramatically there in the last four or five years. I believe the pendulum of economic reform has now swung over to the extent that it is almost like a point of no return."

Chinese government officials also insist that the "Open Door Policy" which has guided the country since the end of the anarchistic Cultural Revolution will remain open, no matter which faction dominates the Congress. This year, China will import no less than $3 billion worth of electronic, computer and telecommunication equipment, including about $1 billion from the United States, according to Zhang Zhi Dong of the Chinese Ministry of Electronics Industry. Zhang, who heads up the China National Electronics Import and Export Corp. in Stamford, Conn., says that while shortages in hard currency have forced China to be more judicious about the products it buys, it still needs U.S. equipment to modernize if it hopes to compete with Hong Kong, South Korea and Taiwan in consumer electronics.

Consumer electronics

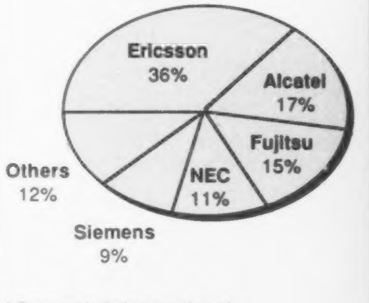
China's goal is to dominate the low end of the consumer electronics market by 1990. While it may take longer than three years to achieve this goal, leading U.S. electronics executives say China's ambitions should not be

CHINA HOPES TO FIND A GLOBAL MARKET for its black-and-white TVs on sale here in a Beijing department store

The 1986 central office switch market in China

Total installed base at year-end 1986*

275,000



* Does not include approximately 1 million in confirmed orders

Source: Tetra International

dismissed lightly. "Today we tend to focus on Japan, Taiwan and South Korea," Jerry R. Junkins, president of Texas Instruments Inc., told stockholders at the company's annual meeting earlier this year. But in the future, Junkins said, those three Asian countries will be joined by other "skilled and aggressive international competitors," including the PRC.

John Roach, chairman and president of Tandy Corp. — the largest consumer electronics retailer in United States with more than 7,100 Radio Shack outlets — concurs. "The Orient has developed the engineering and infrastructure skills — in some cases far beyond those you normally find in the U.S. — that support the electronics industry," Roach recently told *Chief Executive* magazine. "The most likely place to see more production in the future, as it begins to develop its economy, is China."

What's interesting about the China market, however, is that the Chinese appear eager to do business with almost any U.S. high-tech company, even relatively small operations. General Scanning Inc., a $20 million manufacturer of galvanometer-based products in Watertown, Mass., for example, recently concluded a $2 million technology-transfer agreement with a manufacturing company in Guangdong Province. The deal, say Wes Davis, president, involves the sale of about 10,000 galvanometers, plus equipment, documentation and training to go along with them. And Geoquest Systems Inc., a privately held Houston manufacturer of computer-based systems for seismic analysis, reports that it is now close to finalizing a deal to sell MicroVAX-based systems to the Ministry of Petroleum. Geoquest said it first made contact with the Ministry through a petroleum industry symposium in Beijing this spring which was cosponsored by MicroVAX manufacturer Digital Equipment Corp.

Despite these numerous small deals, however, it is the larger U.S. firms which continue to be trailblazers in China's market. □

Hewlett-Packard: A major commitment in Beijing

One of the first U.S. companies to play the China card, Hewlett-Packard Co. also claims to be one of the game's more successful players. The company comanages a 250-person joint venture that manufactures small quantities of computers and test equipment in Beijing and oversees the marketing of practically the complete line of HP equipment throughout the People's Republic.

While the joint venture is said to be profitable, the U.S. parent corporation is guarded about the extent to which it has been able to recoup what is reported to be a $5 million investment in the concern.

Nevertheless, HP continues to pour time and money into what one day could become the biggest market for electronic equipment in Asia. To carve market share in the computer field, for example, Hewlett-Packard is now one of the few companies to accept *reminbi* (RMB) as payment for goods sold, according to Francis Tse, the Singapore-based market development manager for HP's Asia/Pacific Technical System Sector in Hong Kong.

RMB, a local currency, can be used by HP to reimburse domestic workers and pay local suppliers — although most of the componentry used in the sweep generators and other equipment HP manufactures in China is imported. Unfortunately for Hewlett-Packard, though, RMB is not recognized by international monetary markets and so therefore cannot be exchanged for dollars, except at an exorbitant discount within China, for repatriation in the form of profits to the United States.

But that's only one of the many hidden expenses HP and other U.S. companies must contend with while doing business in China. Hewlett-Packard, for example, is also investing heavily in training local personnel. One of the toughest challenges, Tse says, is hiring university graduates with electrical engineering degrees to work in sales, marketing and support rather than in the design areas for which they've been trained. These support functions, however, have become increasingly important, as Chinese customers become more sophisticated about computers and other electronic equipment. "The Chinese end user is finding out now that you just don't buy the equipment, and that's the end of it," Tse says.

Nevertheless, Hewlett-Packard has tried to be flexible, Tse says, because "this is not a hit-and-run situation. This is not like the stock market in which you can make a quick buck and then leave," he says. "Oriental culture requires you have patience and [emphasize] long-term relations. That's why Hewlett-Packard in this for the long term." □

Apple Computer: Clones are the core of the problem

Talk about an image problem. Louis Woo, business development manager for Apple Computer International in Hong Kong, has his work cut out for him.

In the early 1980s, Apple clones from Hong Kong, Singapore and Taiwan flooded the the Chinese market. By year-end 1984, International Data Corp. estimated there were about 20,000 "Apple" personal computers (PCs) in operation in China. Even today, Woo believes that 95% of those Apple and Apple-compatible products in China are clones. "There are tens of thousands of them in China today," he says.

Unfortunately for Apple, though, many Chinese users don't make a distinction between true Apples and cheap Apple lookalikes. As a result, Woo says, some Chinese wonder why Apple, "a company which is so famous on an international scale, has come out with a product which is so lousy in China."

To correct these misconceptions, Apple — which did not officially en-

CIRCUIT DESIGN

Simulation: Building a successful design cycle

Big companies have always used simulation to try out a design before going to production. But now the little guys can play too

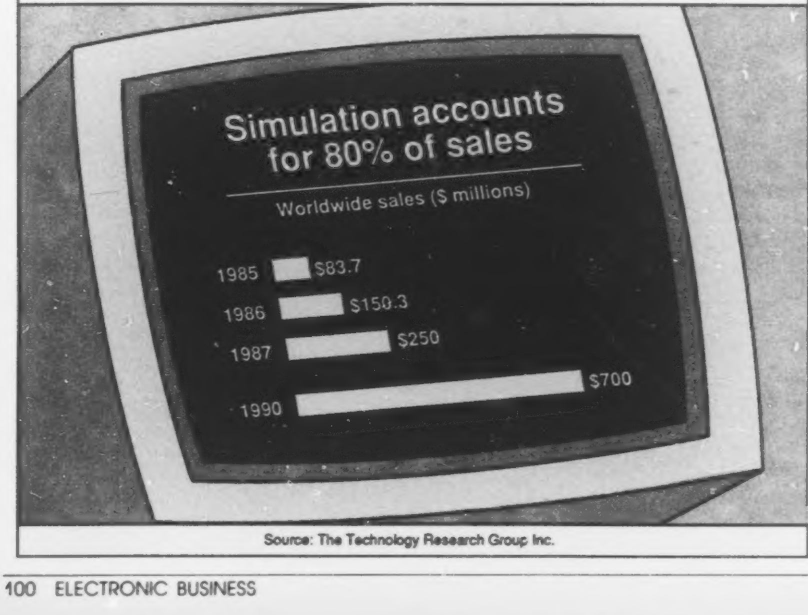
By David Card

In the electronics time-to-market race, getting there is not half the fun. Being late may cost you your profits. By simulating a circuit design in software, companies can shorten the design cycle — cutting down on prototypes and easing test programming. Big players like IBM and Digital Equipment Corp. have known this for years, but only within the last decade has commercial simulation technology started to trickle down to companies with R&D budgets under a half-billion bucks. Now, everybody can do it.

THE MARKET

Sales of commercial simulation software amount to peanuts compared with what companies spend internally. Still, simulation is "not a bad business to be in," according to Andrew Rappaport of Boston market-watcher The Technology Research Group Inc. Rappaport says worldwide commercial simulator sales will grow over 66% this year, reaching $200 million. Sales could go over $500 million by 1990, Rappaport says. Analyst Kenneth Neff of San Jose, California-based market research firm Prime Data Inc., is much more cautious. He estimates 1986 worldwide sales at about $30 million.

Logic and circuit analysis software becomes a big business



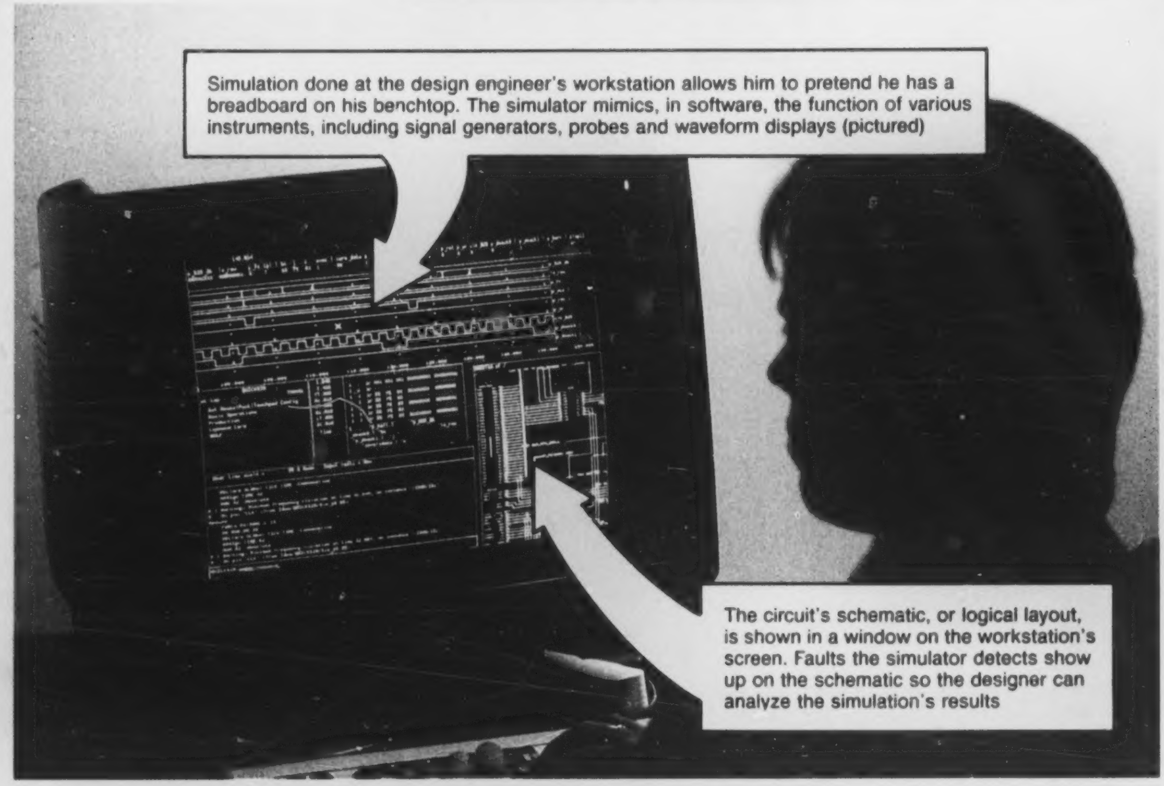
Source: The Technology Research Group Inc.

"There is a large installed base of existing simulators among merchant semiconductor makers," says Lutz Henckels, president of simulator maker HHB Systems, "and they will stick to those." Henckels claims to have wooed Sperry Corp. (now part of Unisys Corp.) away from a proprietary simulator, and says Harris Corp. and Martin Marietta Corp. hold corporate licenses from HHB, as well.

The sales of the top three simulators — Cadat from HHB Systems, Hilo from GenRad Inc. and Lasar from Teradyne Inc. — make up 60% to 70% of the market, according to Jeffrey Hotchkiss, general manager of Teradyne's simulator division in Boston. On the contrary, analyst Rappaport contends that those three are outsold by computer-aided engineering companies. Most CAE companies resell either GenRad or HHB simulators, or make their own as do the custom chip houses. Rappaport says simulation is one of the fastest growing CAE segments.

Hotchkiss says Teradyne has two nearby installations at computer companies where over 130 people use Lasar. But, he says, DEC's simulator has hundreds of users and IBM's, thousands. Yet he lists DEC as a Lasar customer, as well. Hotchkiss sees the greatest potential for simulator sales in the board business, rather than semiconductors, if only for the reason that the number of systems designers dwarfs the number of chip designers.

HHB Systems, a private Mahwah, N.J., company, says sales for its 1987 fiscal year, ended in June, were about



Simulation done at the design engineer's workstation allows him to pretend he has a breadboard on his benchtop. The simulator mimics, in software, the function of various instruments, including signal generators, probes and waveform displays (pictured)

The circuit's schematic, or logical layout, is shown in a window on the workstation's screen. Faults the simulator detects show up on the schematic so the designer can analyze the simulation's results

Mimicking circuits in software

The theory is, that by simulating at the design stage, companies can avoid building costly prototypes or "breadboards." Prototypes are expensive enough in terms of money but, more important, in time to market. The practice is, well, every little bit helps.

"We still prototype. You really can't eliminate that," says Richard Bushroe, director of computer-aided engineering at Apollo Computer Inc. Apollo does about as much simulation as anybody. "The object is to release the product with no redesigns, and simulation is the only way to do that," Bushroe says. It is not unreasonable for Apollo to reduce the time spent debugging prototypes by over 45% via simulation.

In electronics, there are two basic types of simulation: logic and fault. Logic simulators analyze the behavior of a design by exercising a software model of the physical chip or board. Fault simulators run potential errors through that model, checking the model and providing information useful in the development of programs for automatic test equipment (ATE).

Simulators behave at various levels of electrical and logical function. At the transistor level, the simulator looks at what is happening electrically in the circuit — how signals are spreading and which switches are switching. At higher levels, physical functions are modeled according to probability and manipulated by software algorithms.

As an adjunct to board simulation, a market for software models of popular commercial chips is emerging. Also, so-called hardware modelers allow actual chips to be plugged into a simulator. And finally, true system simulation is within range. IBM, say, could give third-party software companies a jump on the market. By getting ahold of the simulation of IBM's latest PC, they could start to write applications software for the machine before it was finished. ☐

Photograph: Dilip Chauhan. Computer: Courtesy Apollo Computer

$13 million, with $2.9 million in profits, according to Henckels. GenRad's simulator sales hit $7.5 million last year, up 25%, ". . . and last year was supposed to be a down year," says Peter Denyer, marketing manager for GenRad's simulator products. GenRad's simulator division operates out of Fareham, England.

"It's a very fragmented market," says Andrew Haines, strategic marketing manager for application-specific integrated circuits (ASICs) at VLSI Technology Inc. in San Jose. VLSI Technology, like most custom chip houses, markets its own proprietary simulator, but must remain friendly to other ones. Haines estimates that there are over 100 commercially available simulators.

The proprietary simulators generally run on big computers — mainframes or networked superminis made by whichever big computer company is using it. Apple Computer Inc. reportedly bought a Cray Research Inc. supercomputer for the purpose of system simulation. The new breed of minisupercomputer makers, many taking advantage of parallel-processing technology, are eyeing the simulation market hungrily.

But there is already an established hardware market — computers opti-

(Continued)

mized to run the lengthy simulation programs. There are a number of companies offering these accelerators, but Zycad Corp. of St. Paul, Minn., is king. Zycad president John Fahlberg says last year's market for big accelerators (other companies make board-level boosters) was worth $30 million, with Zycad accounting for $25 million. Fahlberg thinks the market could reach $200 million by the 1990s.

COST OF ENTRY

The cost of using simulation is not really a consideration, contends Richard Bushroe, director of Apollo Computer Inc.'s internal CAE operations in Chelmsford, Mass. Apollo makes 32-bit engineering workstations, and its market is highly competitive and fast growing. As an example of just how fast that market is, Apollo, after shipping its first computer in 1981, had completely revamped its product line by 1986. The same thing should happen every two or three years, Bushroe estimates.

Apollo is a serious user of simulation. It has about 150 hardware designers, half of whom do simulation in any given day. Another half of its diagnostics team of 20 simulate test cases for software development. Apollo uses simulators from many sources, including: chip simulators from CAE vendor Mentor Graphics Corp. of Beaverton, Ore., and chip maker LSI Logic Corp. of Milpitas, Calif.; board and subsystem simulators from Aida Corp. of Santa Clara, Calif., and Gateway Design Automation Corp. of Westford, Mass.; and a system for microcode development from Endot Inc. of Cleveland. Apollo also uses a Zycad accelerator and board-level accelerators from Aida.

JOHN FAHLBERG, Zycad's president: The market for accelerators could reach $200 million by the 1990s

RICHARD BUSHROE, director of Apollo Computer Inc.'s internal CAE operations: The justification for simulation "is not with savings, it is because it is absolutley necessary to get the job done"

Dilip Chauhan

Still, Bushroe estimates that simulation takes only a fraction of Apollo's $44.7 million R&D budget, well under 10%. Bushroe does not justify simulation on savings. "It's not because of the cost," he says, "it's because you can't do designs that are state of the art unless you have these tools. You can't get to market in time, especially with the competitiveness the way it is. The justification is not with savings, it is because it is absolutely necessary to get the job done."

In general, simulators run about $20,000 to $35,000 per workstation license. Licenses for bigger computers cost more, but the breakdown to per-seat considerations is about the same.

If you want to build your own simulator, it can be done. HHB originally spun out of GenRad's simulator operations back in 1975. HHB survived as a consulting firm for simulation and test programming, writing a simulator for Siemens AG in 1982. That deal was worth about $7 million. In 1983 HHB introduced Cadat, then booked a first round of financing worth $1 million. Since then, the company has made a living on Cadat, with a little $5 million help from Schlumberger Ltd. At press time, HHB was in the process of closing a second round of venture capital in the $4 million range.

Gateway Design president Prabhu Goel worked at IBM's East Fishkill, N.Y., chip facility, then at Wang Laboratories Inc. before founding his company. He claims to have written his first simulator on a rented Radio Shack computer. At VLSI Technology, they are a little more traditional. ASIC marketing manager Haines says VLSI Technology has about six or seven man-years worth of effort in its logic simulator. The total cost was around three-quarters of a million dollars.

THE COMPETITION

"Our simulator is 5 years old, going on 6," Haines says. "We are loath to go to somebody else's simulator and start the process all over again." That is part of the reason the market is competitive. Haines adds that any physical design tools are dependent on a particular chip maker's manufacturing process. The same, to a degree, could be said for simulators.

"We can't pretend we're not in the business," Haines says. The nonrecurring engineering costs of custom chips, which include simulation,

RICHARD ROGERS, GenRad's chief operating offic[illegible]e don't sell Hilo to make money through those programs, but to sell testers"

make up 40% of ASIC sales, Haines says. "We can't give simulation away because only 25% to 50% of all chip designs actually go into production."

ASIC foundries are rated on the strength of their silicon compilers, their physical layout tools and their simulators, says Daniel Pujol, general manager of Schlumberger's chip tester division, Sentry, in San Jose. "They will never share that with outsiders," he says. Hence, Schlumberger's investment in HHB. Actually, sharing is a relative term. Both VLSI Technology and, recently, LSI Logic, sell a subset of their design and simulation tools.

The two test companies could not have more dissimilar strategies for marketing their simulators. Teradyne sells Lasar itself, along with a parallel-processor computer from Sequent Computer Systems Inc. of Beaverton. Teradyne also sells a CAE package from Viewlogic Systems Inc. of Marlborough, Mass. "Teradyne's trying to position themselves as a one-stop shop, turnkey CAE vendor," guesses GenRad's Denyer. "They're playing on somebody else's hill. I try to stay on a hill I can defend."

GenRad has gone the other route, licensing Hilo on an original equipment manufacturing basis to such potential big hitters in CAE as Hewlett-Packard Co., Intergraph Corp. and Tektronix Inc. GenRad also sells direct. "Actually, the sales through the OEM channel have not been significant," says GenRad chief operating officer Richard Rogers. "We're leveraging the penetration of Hilo. We don't sell Hilo to make money through those programs, but to sell testers."

In direct contrast, Teradyne's Hotchkiss says: "My charter is to be successful within design, independent of the test business . . . . My success is measured by how well we do against Daisy, Mentor and Valid, not how many testers we sell." Daisy Systems Corp., Mentor and Valid Logic Systems Inc. are the three CAE market leaders.

Hotchkiss admits that the original reason for offering a simulator — Teradyne bought an LTV Corp. simulation spin-off, Digitest, in 1972 — was for test. Certain circuit-board test equipment is notoriously difficult to program, he says. Simulators produce data useful in programming, and give a design-to-test link craved by ATE companies. "GenRad began to get more market share with Caps," an early simulator, Hotchkiss says. "Lasar was a defensive move."

Now, simulation has become a strategic issue. The simulator "is the core analysis tool of a designer," Hotchkiss contends. Teradyne has to either "control it, or get designed out of the process." Hotchkiss thinks GenRad's strategy is the risky one, as it could lose control of Hilo to its OEMs. "I'd be amazed if they don't bring out their own simulators," he says. He points to an ill-fated deal between HHB and Mentor as a case study.

HHB originally sold a chunk of Cadat to Mentor, which Mentor evolved into its own, competitive simulator. HHB's Henckels calls that deal a "screw up" that he will not let happen again. From now on, the code stays home. Even with that lesson, the battle for OEMs is pretty ferocious. Henckels gloats that he recently stole Computervision Corp. away from GenRad. GenRad's Rogers retorts: "If we lost HP or Tek, I'd be worried."

Another Beaverton start-up, Analogy Inc., picked its market accordingly. President R. Larry Jacob aims his simulator specifically on analog circuits, rather than the fierce digital market. "We focused on analog boards because there was no competition," Jacob says. He has signed up CAE board specialists Cadnetix Corp. and Racal-Redac Ltd. as OEMs.

THE OBSTACLES

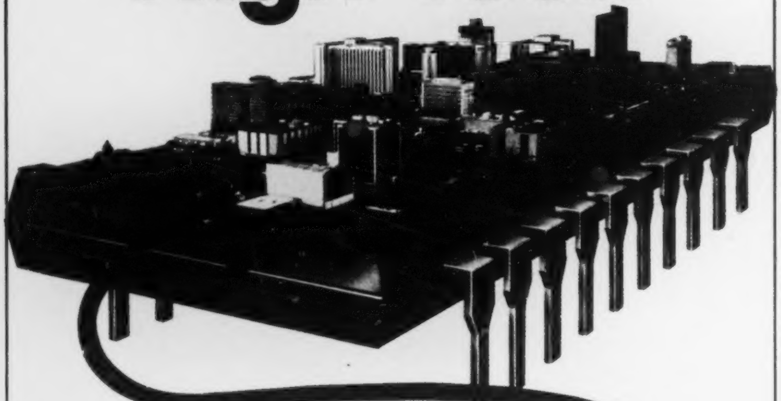
To feed a board simulator, companies must have access to detailed models of the chips that will populate it. The problem is, Motorola Inc. does not want the heart of its latest microprocessor's functionality to fall into the hands of Intel Corp., or vice versa.

Building a model is no fun. Apollo's Bushroe says that it could take up to two years to develop a software model for Motorola's 68020, the heart of Apollo's workstations. Apollo gets around that by using Mentor's hardware modeler, which allows an actual 68020 to be plugged into the simulator.

Still, not every chip is covered. The accurate timing measurements crucial to a chip model do not come with the catalog, says HHB's Henckels. "To be blessed with those costs $400,000," from, for example, LSI Logic, he says. Adds VLSI Technology's Haines: "Nobody wants to write models for the Intel 8086 or the 80386. We don't want to do it."

Fortunately, somebody does. Apollo buys models from Beaverton's Logic Automation, and Quadtree of Bridgewater, N.J. "These companies open up a whole new area of business for our type of companies," says Gateway Design's Goel. "Now, there can be tremendous growth in card, board and system simulation." Gateway has deals with both Logic Automation and Quadtree. Quadtree just introduced a service that president Roger Hobbs says can automatically

Henry Hilliard



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generate models from a chip's data sheet.

The hardware limitations are fading also. In fact, they may be fading the business opportunity away. Apollo uses Mentor's accelerator, and for really big designs, a $1 million machine from Zycad. But Bushroe says: "As time went on, tools like Aida's came along." Aida makes a plug-in board for Apollo workstations to speed up its simulator. It priced Zycad right out of the market, according to Bushroe.

In addition to that, the simulators are getting more clever. Gateway Design's Goel claims his does not need an accelerator. It can run efficiently on a workstation because it does not bother to simulate every single event sequentially. For example, if a particular signal does not affect a particular gate, the simulator recognizes that and skips over that gate. "From a business standpoint, hardware accelerators are going to have a hard time competing," Goel says. "At any given time they can reduce the algorithm to hardware and gain a quantum jump in performance. But they can't maintain that jump."

Mentor has as much as acknowledged that argument. "We're not going to invest heavily on that in the future," Mentor president Gerard Langeler says of his accelerator. Instead, Mentor will rely on Apollo keeping up in the computer performance race. Mentor also just signed a deal to resell Zycad accelerators.

Zycad, of course, takes a different point of view. "Even though there will be more parallel-processing MIPS [millions of instructions per second, a popular way of gauging processing speed], and even 30-MIPS workstations, our customers say that's just not going to hack it," president Fahlberg says. "At five [thousand] to 10 thousand gates, all of a sudden you have a simulation bottleneck," he says.

Zycad has gotten its price down: it now offers a variety of price/performance boundaries. But one way it did it was by buying out a competitor, Silicon Solutions, of Menlo Park, Calif. Zycad had to swallow $12 million in merger costs, and suffered a layoff and the resignation of its president. Zycad dumped a program to build a board-level accelerator, Fahlberg says. Still, the market is interesting enough to sponsor another start-up, XCAT Inc. of Hopkins, Minn. ☐

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The restructuring of the U.S. resistor industry

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The IBM PS/2: The birth of a billion-dollar industry

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FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES

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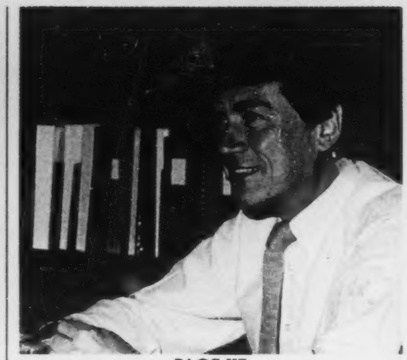

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BPA ABP

The semiconductor industry is back in the black again

Don't look for a 1984-style boom, but there is reason to forecast sustained second-half growth

The U.S. semiconductor industry appears to be firmly in the black, after recording continued growth through the second quarter of 1987. In fact, the industry is now operating at a $10 billion per year run rate, according to the Semiconductor Industry Association. Business must be improving; semiconductor manufacturers have not seen a run rate like that since the boom of 1984.

Recent forecasts from Cahners Economics are equally optimistic. Cahners is forecasting the second quarter of 1987 to show total U.S. semiconductor sales of $2.45 billion, up from $2.24 billion in the first quarter, and also up from 1986's second quarter figure of $2.20 billion. Third quarter 1987 is expected to drop slightly to $2.42, but then rebound strongly to end the year with $2.69 billion in sales.

Another measure of growth shows semiconductor distributor shipments also very positive. Cahners forecasts second quarter 1987 distributors' shipments at $573.3 million, up dramatically from first quarter's figure of $473.6 million. Compared with the the 1986 second quarter figure of $592.3 million, however, distributor's shipments are down somewhat. For the remainder of the year, Cahners predicts that distributors' shipments will continue to increase, growing to $600.1 million in the third quarter and to $643.4 million in the fourth quarter.

With two strong growth quarters behind it this year, some semiconductor pundits are beginning to treat the recovery as something real, rather than a panic-buying phenomenon. It would seem that inventory stockpiling, the scourge of the industry several years ago, has decreased dramatically, as business in the user industries (particularly computer and industrial) continues to show real growth.

Traditionally conservative — and therefore often accurate — market research firm In-Stat Inc. is "relatively optimistic" regarding business this year. Says vice president William Groves: "I think the business is real. I've seen some people get excited about the growth because it is reminiscent of olden times. Overall, this year is good, but it is not another 1984."

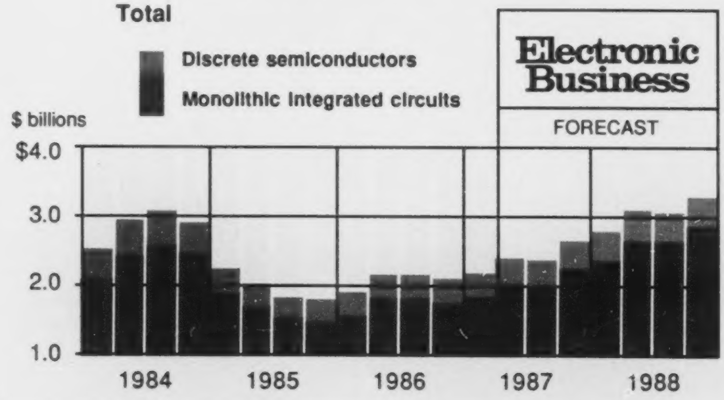
This year might not be another 1984, but it is strong enough for some semiconductor companies to return to profitability. Last year's second quarter results had almost all of the major companies in the red, including Intel Corp. with a $20.4 million loss, Advanced Micro Devices Inc., with a $28 million loss, and National Semiconductor with heavy losses as well. This year's second quarter calendar year results brought AMD and National into the black, and gave Intel record quarterly growth of 43%.

One reason for the growth, certainly, is the strength of the personal computer business.

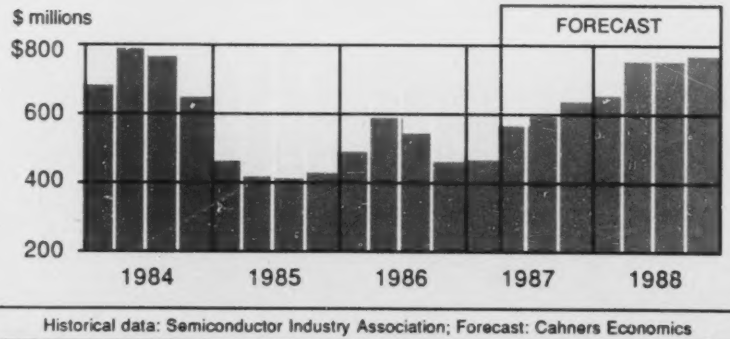
VALERIE RICE

Semiconductors

U.S semiconductor sales

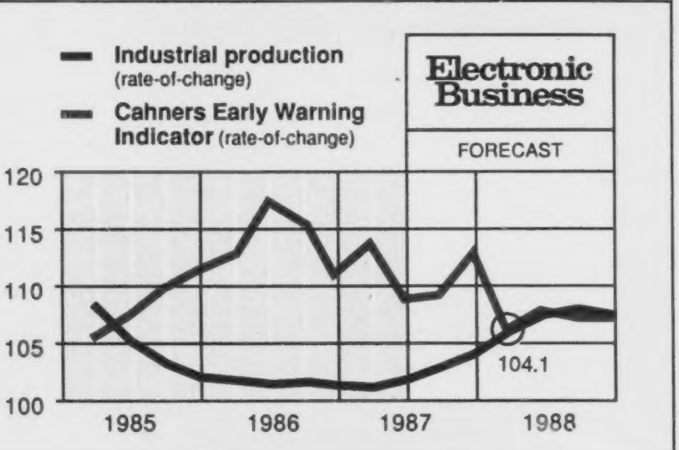


U.S. semiconductor distributor shipments

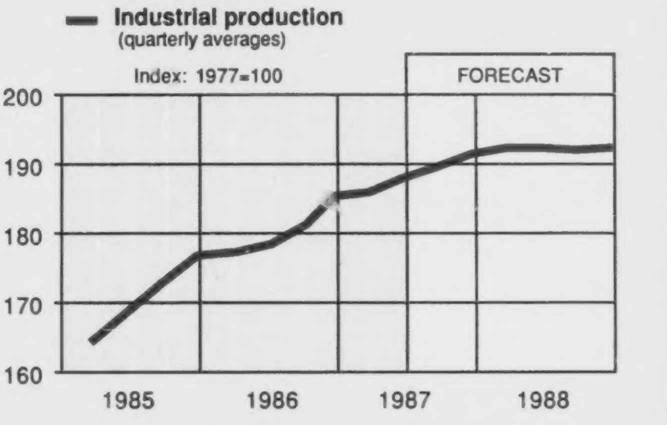


Historical data: Semiconductor Industry Association; Forecast: Cahners Economics

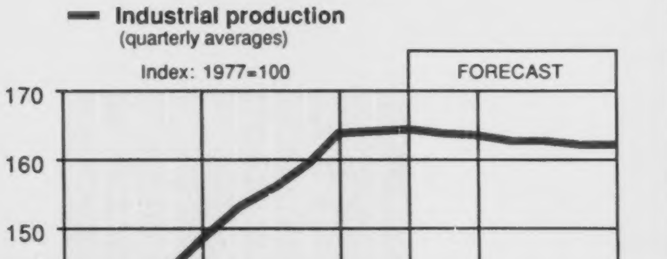
Economic indicators



Defense and space equipment



Aircraft and parts



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

Steady growth expected

The United States Index of Industrial Production, a coincident indicator of the U.S. economy, has been climbing steadily since the summer of 1986. The fourth quarter was up 0.7% from the prior quarter bringing yearly production up 1%. This year, modest gains are expected to continue through mid-year (first quarter production rose by 0.6%) with sharper increases in industrial production expected in the third and fourth quarters.

The Cahners Early Warning Indicator (CEWI) is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index. It forecasts probable business cycles about 12 months in advance. The black curve is a plot of the 12-month rate of change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 104.1 level forecasts using the CEWI for the end of this year indicates that the average for all of 1987 should be 4.1% above 1986. *More information can be obtained from Elizabeth Baatz, economist, Cahners Economics Department, 275 Washington St. Newton, Mass. 02158.*

Defense and space equipment

Budget reductions have squeezed growth in the defense and aerospace markets since the end of 1984 and will continue to act as a restraint throughout 1987-1988. First-quarter production was up 0.5% from the level in the previous three months and outpaced the year-ago quarter by 5.1%. Peak growth rates for this cycle were about twice as high. Cutbacks have taken their greatest toll on military equipment procurement and R&D funding, which together account for about 37% of total spending. The cuts have taken the form of stretched-out program schedules and a growing shift toward electronic modernization rather than new equipment development. Look for production to continue on a slow climb, increasing 4.7% for all of 1987 and just 1.9% in 1988.

Aircraft and parts

Until recently, the aircraft and parts industry had been growing at a healthy pace. But reports for early 1987 provided evidence that the market expansion has begun to lose steam. Production in the first three months of this year showed a gain of just 0.4% over the prior quarter, the smallest advance since the beginning of 1984. Growth on a year-to-year basis, meanwhile, slowed to 7.5% from 10.2% in the final three months of 1986. Declines in the defense sector are expected to produce a further moderation in the marketplace over the next 12 to 18 months.

services company, says: "The Fiat-IBM alliance is significant. They are positioning themselves to be present in a market which is still in its infancy — but with good prospects for growth in Italy and elsewhere in Europe."

Kees Mulder, senior telecommunications consultant at Link Resources Inc.'s European office in London, believes that IBM will have its work cut out for it to become established as a full-fledged player in value-added networks (VANs) in Italy. "It's not just a matter of deregulating a government telecommunications monopoly in Italy," Mulder explains. "The problem is to coordinate a host of bureaucratic organizations involved in Italian telecoms. It's a real melting pot over there."

At Dataquest, Ted Richardson says: "IBM has adopted a pragmatic approach in joining forces with Fiat because it could not have achieved this result on its own. IBM is trying to present itself as more European in order to seize opportunities that it could not grasp as a U.S. group."

British inroads

In another move, IBM is stepping into Britain's fast-growing cellular telephone market, enabling subscribers to access its data networks via portable computers in their cars. Users of Cellnet and Vodafone, the two British cellular networks, will be able to use electronic mail and financial information services. An IBM official in London says: "We are continually looking for new ways to help our customers hook up to our network. -

Although IBM launched its British VAN early last year, customers so far had only limited access to its international networks which cover Israel, Japan, the United States and 13 European countries. Now, IBM is offering British users wider opportunities to log on. It is giving particular emphasis to extending its trade data interchange service, which allows transmission of business documents relating to buying and selling.

IBM hopes this strategy will enable it to play a bigger role in the British market for such services where ICL Ltd., Britain's largest national computer company, is strong. Big Blue is currently equipping its computer center in Warwick, England, to make this its second European control center for VANs. The other is located at Zoetermeer in the Netherlands.

JACK GEE

MILITARY

Core hangs onto its niche in military electronics

Everyone wants to write the definitive obituary for core memory, but core is one technology that won't die

Let's not kid ourselves. Core memory, the primary computer storage medium in the 1960s, is hardly putting semiconductor makers on the endangered list. Commercial applications dried up years ago, and now even the military is forsaking core for chips.

But try telling that to the half-dozen vendors still making a lucrative living at it. Dean Knutson, manager of products and programs for Ampex Corp.'s Computer Products Division in El Segundo, Calif., sums up their never-say-die attitude: "Our goal is to be the one that turns out the lights, whenever that is," he declares.

It may not be this century. Core is central to many military programs running well into the 1990s. It is easy and inexpensive to "harden" core against nuclear radiation, and little else can equal its ability to store data in what the military calls "severe environments." And core makers pin hope on new programs like the small intercontinental ballistic missile (SICBM) and the Strategic Defense Initiative (SDI), where core's nonvolatility and natural radiation resistance may prove crucial.

Lobbying effort

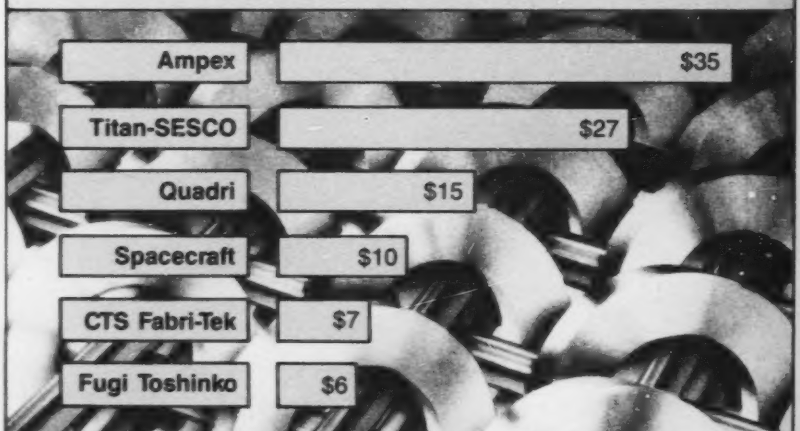
To try to enhance core's prospects with these programs, Ampex's Knutson is feeling out support for action that core makers have never taken before: a concerted lobbying effort for Defense Department funding of new core development.

Core stores binary data on microscopic ferrite rings that are cut out of tape and strung on wire like beads. Signals along one wire flip the memory from "zero" to "one" and back; another wire "reads" that condition. Its prime plus-point is its nonvolatility; power can be lost and the memory remains intact, as witnessed by investigators who recovered data from the core memories in the IBM AP101 computers on the Challenger space shuttle after the equipment had been blown up, burned and soaked in salt water.

The first commercially available

Core memories: Forgotten but not dead

1986 core memory sales ($ millions)



Source Dataquest Inc.

core appeared in 1956, and soon became the mainstay of computer memory. It also remembered the order of songs requested on jukeboxes. By the early 1970s, core had grown to what some say was a billion dollar a year business. But with the emergence of semiconductors, core lost markets wholesale, and by 1980, had been almost entirely replaced in commercial use. Today, Dataquest, a San Jose, Calif., market research firm, puts worldwide shipments — almost all military — at about $100 million annually. "We were a little surprised to find it was as large as it was," says analyst Robert Gaskin.

Profitability is surprisingly high too, although not one vendor will disclose just how high. "Core made the majority of our money last year," says Bryan Rickard, vice president for memory and power-supply programs at Titan Corp.'s Severe Environment Systems Co. (SESCO) in Chatsworth Calif. Adds Harold Ergott, president of Tempe, Arizona-based Quadri Corp.: "It has been profitable enough for us to use the cash for other businesses."

Core has hovered near the $100 million level for four or five years, and insiders reckon it will stay there for another five. "They've kept it alive with miniaturization of the core itself," explains Gerald Holland, a design section manager with Litton Industries Inc.'s Guidance and Control Systems Division.

Three decades ago, when one scientific journal was predicting core's imminent demise, a small core's inside diameter was 50 millionths of an inch (mils). Today, 13 mil is the standard, 9 mil is common and 6 mil is in the labs at Ampex. Consequently, vendors that in 1970 were gleeful over packing 8k x 18 (8,000 18-bit words) onto a core array now put 64k x 18 modules in the same 6 x 9 x 1.4-inch package, the de facto standard for the likes of the AYK-14 airborne computer developed by Control Data Corp. during the mid-1970s.

How dense can you get

How much higher densities can go is questionable. Modules of 128k capacity using 9-mil cores are near production; Ampex is studying 6-mil cores, but has no plans to produce them yet. The real problem is stringing such miniscule rings, a task that remains labor intensive, and is carried out mostly in the Far East since fully automated stringing does not exist.

Core's military use is widespread. Besides the space shuttle avionics, core appears in the IBM systems aboard the B-1B bomber. Litton features it in the Cruise missile's inertial navigation unit, and in the electronic-warfare system of the F-4 plane. Core stores data in sonar and in satellites. More recently, a 64k radiation-hardened module was incorporated into ground control of MX missiles.

But semiconductors — notably electrically erasable read-only memories (EEPROMs) are gaining ground despite their slower data-writing speeds and limited number of write cycles. The chips exceeded core in price/performance perhaps three years ago. Several contractors have abandoned core already; Unisys Corp.'s military-computer divisions claim core's reliability and speed were inferior. Honeywell Inc. adds core's cost and bulk to Unisys' reasons for discontinued use. Recently, British Aerospace Plc converted the main computer in its Rapier ground-air defense system to EEPROMs.

The core market has hovered near the $100 million level for about five years, and insiders reckon it will stay there for another five

Others are following. IBM's Federal Systems Division in Owego, N.Y., won awards this year to design chips into the shuttle computers by 1989. Big Blue is also retrofitting semiconductors to Airborne Warning and Control System (AWACS) units.

Vendors appear unperturbed; they have been living with core's end for decades. Few remain entirely dependent on the older technology: Ampex's Computer Products Division now derives 60% of its sales from display terminals, and SESCO, with just over half its revenue from core, gets another 33% from ruggedized computers and 5% from chips. Both firms were virtually 100% core 15 years ago.

One player, CTS Fabri-Tek Inc. of Minneapolis, is itself experimenting with EEPROMs, and has put half a megabyte in semiconductors into the 6 x 9 x 1.4-inch package it is sending out for evaluation soon. According to Sherm Beyl, sales and marketing manager, this diversification plan contains a message: "We're memory-system designers, not just core stringers," he asserts.

Others, like Quadri, are studying bubble memory as well as winning competitions for the specialized core that makes up to 15% of Quadri's sales and helps fuel the 35% annual revenue growth that president Ergott reports. "What we see increasing is radiation-hardened nondestructive read-out [NDRO] memory. That is a wedge of growth that will be on top of our standard core business," he says. He expects this wedge to grow at least 20% annually, since hardened core memories maintain strong cost advantages over radiation-resistant semiconductors.

Another hope for core vendors is bulk storage, the multimegabyte mass memory needed for highly computational work, like satellite image processing or missile threat assessment. Suppliers hope core will be considered to replace disk drives. SESCO makes a 1024k x 18 mass memory; Ampex's 1-megabyte Megastore-9 is in product qualification.

Nowhere will radiation-hardening and mass memory be more critical than in SDI, or Star Wars, programs and in prospects like the SICBM and the rail-mounted MX missile proposal. "If the SICBM goes core, then core has a real bright future," says Ampex's Knutson.

But the services may not consider core exotic enough; vendors complain that they can't even get papers published at technical conferences. "It doesn't have a modern ring to it," concedes SESCO's Rickard. Consequently, any lobbying efforts for Pentagon funding, if they come to pass, may be too little, too late.

Meanwhile, core players concentrate on today's programs. Ampex sees business dipping slightly in 1988 because of program stretch-outs but picking up again in 1989. And beyond the 1990s? The firms that jokingly claim to be on the leading edge of a trailing-edge technology insist that the demise of core memory, like Mark Twain's death, has been greatly exaggerated. Yet they accept the inevitable: "There's got to be a day when these things go to the museum," says Knutson.

JOHN KERR

INDUSTRIAL OEMs

Waiting is the name of the PS/2 game

Industrial OEMs are looking for software, demand and market acceptance before committing to IBM's Personal System/2

By Anne Knowles

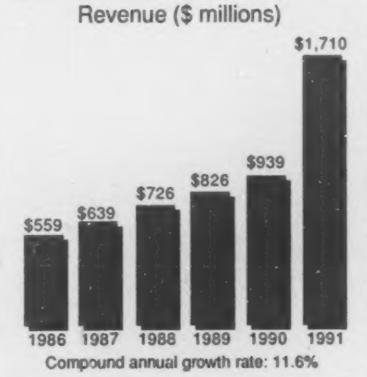
To hear original equipment manufacturers tell it, IBM's second generation microcomputer is just another piece of hardware. IBM's Personal System/2 presents some problems, they say, but none that cannot be overcome. Interfaces will have to be redesigned for IBM's new proprietary bus, called the Micro Channel, but that won't be too difficult. The PS/2, which contains less slots for add-in boards than its predecessor, houses enough slots for most OEM purposes. And IBM's switch to 3.5-inch media presents more of a headache than a real obstacle.

So, why the lack of enthusiasm? Big Blue made it easier to buy and resell its new personal computers than many had anticipated. The lukewarm reception to IBM's PS/2 among industrial OEMs, instrument makers and computer-aided engineering (CAE) vendors is not due to disinterest. On the contrary, many technical OEMs assume their customers will eventually migrate to the new computers.

But the question is when. Rather than rushing to market with products based on the PS/2, many OEMs are taking a wait-and-see approach. And what many OEMs are waiting to see is software.

"We won't introduce anything until OS/2 comes out," says Michael Thiemann, vice president for marketing at Summation Inc., an automatic test equipment supplier in Kirkland, Wash. OS/2, the operating system developed by Microsoft Corp. of Bellevue, Wash., will not be unveiled until the first quarter of 1988. It is expected to overcome some of the limitations set by MS/DOS, the operating system which runs on IBM PCs. But some OEMs question when OS/2 will be fully functional.

PC growth in the U.S. manufacturing market



Compound annual growth rate: 11.6%

Source: Dataquest Inc.

"The first version doesn't address the needs of the market," says Don Richman, director of marketing at CASE Technology Inc., a Mountain View, California-based CAE vendor. "It won't provide true multitasking," or the ability to run numerous programs simultaneously, contends Richman. "It makes more sense to support Release 2," says Richman.

The multitasking difference

"Multitasking is what is going to really make a difference to us," says Mike Todd, marketing manager for John Fluke Manufacturing Company Inc.'s manufacturing and R&D applications group. Fluke, which once resold the PC as a test instrument and for data-acquisition applications, now only supplies software driver packages, or toolboxes, which aid customers in the use of the PC as an instrument controller. But because moving its current software over to a new operating system is a "tedious process," says Todd, and because "there hasn't been much demand for it," Fluke plans to wait for market acceptance of the PS/2 before formalizing its plans.

Vendors are not only waiting for OS/2 but for applications written for the new operating system. Existing application packages should run on the first release of OS/2 with little modification, says Curt Grina, vice president for marketing at Centec Corp., a Reston, Virginia-based supplier of manufacturing software written for the PC which runs MS/DOS. "The real task," says Grina, "comes with the second version [of OS/2]. Like everyone else," says Grina, "we're impatient."

"Driving acceptance of the PS/2 is availability of software," says David Penning, an analyst with Dataquest Inc., San Jose, Calif. Hardware, at least on the factory floor, is not the issue. "There is not much need for functions above what an XT can do," says Penning.

Jim Flanagan, marketing director for Analog Devices Inc.'s industrial automation division, agrees. Flanagan does not foresee potential demand for the PS/2 coming from Analog's existing customers that are content with their current systems based on IBM's PC AT. "At this particular point in time, there is not much demand," he says. Demand for the PS/2, if and when it comes, says Flanagan, will probably emanate from new customers.

Analog's Macsym 120, which the company no longer sells, was based on IBM's industrial PC. Currently, Analog offers board-level products for IBM PC ATs and XTs used in data acquisition. Analog is evaluating the PS/2 and plans to offer boards for the new system, "when appropriate," says Flanagan.

But Analog has not reached a decision whether to resell the PS/2. Analog and IBM have yet to reach an agreement, says Flanagan, and IBM has yet to offer a ruggedized, or industrialized, version of the PS/2. IBM does not currently offer a ruggedized PS/2 for industrial OEMs although the company has supplied industrialized versions of its microcomputers in the past. "That," says Analog's Flanagan, "is the biggest waiting factor," holding up Analog's decision whether to buy IBM's new computers for incorporation into industrial automation systems. In the event that IBM does not eventually supply industrialized PS/2 models, Analog would consider buying compatible machines from another vendor.

Summation is also considering buying PS/2 clones if necessary. Even though the company would prefer to work with IBM, says Thiemann, up to 50% of its sales are ruggedized systems. "We prefer to work with IBM. It is our customers' first choice." Explains Theimann: "Only when they don't offer what we need do we turn to someone else." Today, roughly 25% of Summation's systems are based on hardware from COMPAQ Computer Corp., Digital Equipment Corp. and Wyse Technology Corp.

Allen-Bradley's plans

Allen-Bradley Co. of Cleveland sells three industrial systems based on IBM's AT and XT. During evaluation of the PS/2, the company is under a nondisclosure agreement with IBM and cannot discuss its plans for the new system. But according to Bruce Hammond, Allen-Bradley's manager of commercial marketing, the company designed IBM's new bus, the Micro Channel, into its high-end system based on the PC AT at the beginning of this year.

Currently, the company's three models based on IBM's PCs — the XT-based 6120, and the 6121 and 6122, both based on the AT — account for more than a third of Allen-Bradley's industrial computer division sales. But in the beginning of the year, the company introduced a line of board-level products for PCs. Inclusion of IBM's new bus in an existing AT-based product may be an indication that Allen-Bradley plans to emphasize its add-in board business rather than resell complete systems bought from IBM.

In the manufacturing market, says Dataquest's Penning, there is a movement away from programmable logic controllers to personal computers because PCs can do all that PLCs can do, and more. Allen-Bradley, which is No. 1 in the PLC market, says Penning, "certainly recognizes this trend."

Another trend, says Dataquest's Penning, is that customers are increasingly buying computers directly from computer manufacturers, rather than OEMs, and then buying add-in boards from industrial automation vendors such as Allen-Bradley. Accordingly, says Penning, Allen-Bradley will increasingly shift its product line to add-in boards.

In the OEM industry, the shift away from selling turnkey systems is most evident in the CAE market [ELECTRONIC BUSINESS, June 15 p64]. Cadnetix Corp., CASE Technology, FutureNet Corp., Personal CAD Systems Inc., Racal-Redac Inc. and Viewlogic Systems Inc. are all CAE or CAD vendors that either currently offer or plan to offer software for the PS/2. But CASE is the only one that currently provides turnkey systems, based on the AT, for customers. And the hardware portion of the company's business, says CASE's Richman, is down to 1% of sales. CASE is now deciding whether it would be wise for the company to resell the PS/2 at all. "We are doing a risk assessment within CASE on whether to support both hardware and software," says Richman. "Design automation markets," concludes Richman, "are turning away from bundled, turnkey systems."

PCs in the electronic CAE market

	1986	1987
Revenue ($ millions)		
Total CAE	$919	$1,036
PC share	22%	24%
Units		
Total CAE	14,327	16,900
PC share	63%	61%

Source: Dataquest Inc.

A blunt assessment

O'Neil Feltman, vice president for marketing at Cadnetix, in Boulder, Colo., puts it more bluntly. Reselling PCs, says Feltman, "is a bad way to make money. You lose 10% on inventory costs alone." And even though Cadnetix plans to supply software for the PS/2, the company is in no hurry to get to market. "There are two reasons why we're not busily working on that. One is, we're waiting for it all to settle out. The other is, you don't really need it in the CAE environment," says Feltman, because of servers. In addition, he says there are 3 million PC ATs installed with graphic capabilities that Cadnetix needs to address first.

The proliferation of customers that have bought PCs has affected instrument companies as well. While Hewlett-Packard Co. is still strong in instruments and DEC has a presence through OEMs, "the AT is becoming the computer of choice in the instruments market," says Galen Wampler, president of Prime Data, a market research firm in San Jose. "At least 80% [of PC-based test instruments] use IBM PCs or clones," says Wampler. "And in the majority of cases," says Wampler, "customers are moving to buying their own PCs," direct from the PC maker.

James Cavoretto, vice president for engineering at Northwest Instruments Systems Inc., agrees. Although the Beaverton, Oregon-based instrument company still sells systems, based on both COMPAQ and IBM hardware, "our actual selling of the computer is becoming less and less a portion of the business," says Cavoretto. The company's primary business has become plug-in cards and software.

Northwest Instruments hopes to decide this month or next whether to follow IBM's PS/2 path. "If the market moves in that direction we plan to provide support," says Cavoretto. "We are mostly driven by our customers and how well it is accepted in the engineering environment."

Cavoretto says that designing a new interface will not be difficult because, "it is not an exotic card." But, because Northwest customers require 5.25-inch hard disks, "we'll be faced with having to distribute software in two media," if the company supports the PS/2, which uses 3.5-inch disks. Even though Cavoretto is impressed by OS/2, the company is also evaluating Unix. "We'll be facing modification of our software in any event," says Cavoretto.

All of this reflection has given Northwest time to also consider alternatives. "Many companies that address the engineering enviroment are looking at workstations," says Cavoretto. Northwest is currently contemplating switching to either Apollo Computer Inc. or Sun Microsystems Inc. workstations.- ☐

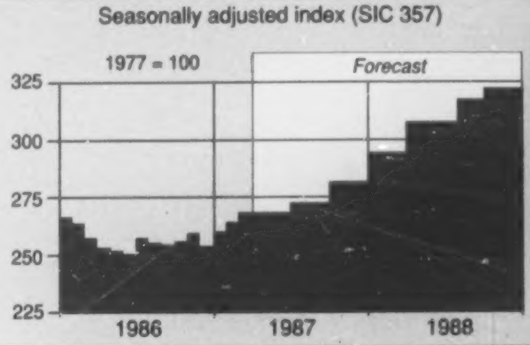
DATABASE

Recovery pick ups the tempo

The recovery in the market for computers, peripherals and related equipment (SIC 357) picked up the tempo in the first half of 1987. By this spring, production was running more than 7% ahead of the level at the low for this cycle, which occurred in June 1986. Employment was showing signs of stabilization after more than two years of almost uninterrupted declines. Domestic demand was improving steadily, as buyers stepped up their outlays for PCs, minicomputers, technical workstations and peripherals. Finally, there was continued evidence that the steep decline in the dollar since early 1985 was having a favorable effect on foreign trade. Exports by U.S. manufacturers were up an estimated 17.5% over year-earlier levels through May, approximately six percentage points above the comparable growth rate in imports. These data all indicate that the market recovery is firmly in place.

Compiled by LINDA STALLMANN

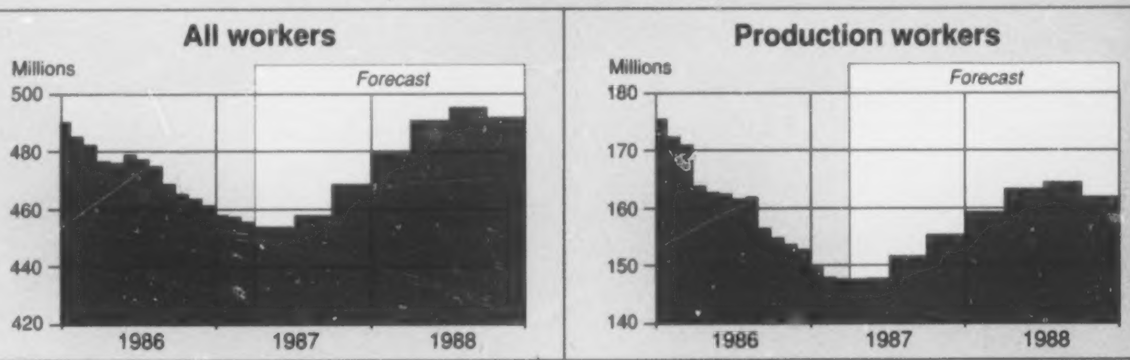
Computer industrial production



April 1987	March 1987	April 1986
268.4	268.7	252.9

Source: Federal Reserve Board; Forecast: Cahners Economics

Computer industry employment



All workers

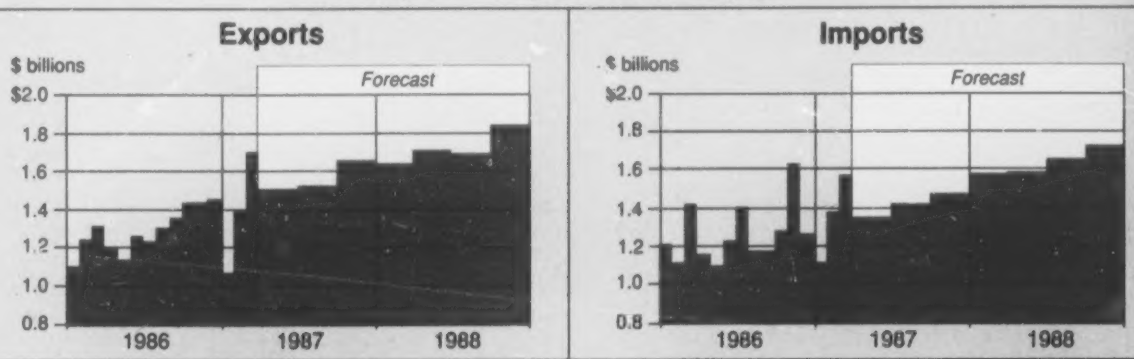
May 1987	April 1987	May 1986
453.9	453.9	476.4

Production workers

May 1987	April 1987	May 1986
147.7	147.5	162.8

Source: U.S. Department of Labor; Forecast: Cahners Economics

Computer exports and imports



Exports

May 1987	April 1987	May 1986
$1.519	$1.392	$1.139

Imports

April 1987	May 1987	May 1986
$1.411	$1.557	$1.157

Source: U.S. Department of Commerce; Forecast: Cahners Economics

INDUSTRY OVERVIEW

Board builders: Bringing the business back home

The landscape is changing on printed circuit boards. New technologies and philosophies mean survival of the fittest

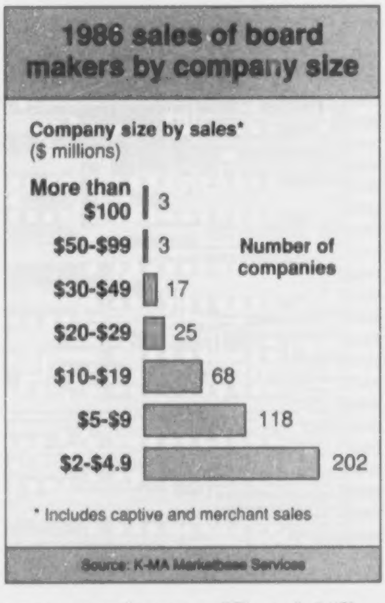
By Bruce C.P. Rayner

With each successive boom-bust cycle, the overpopulated merchant board industry lunges closer toward maturity. The 1985-1986 downturn was no exception as some 100 companies out of a U.S. population of about 1,000 bit the dust. Compounding this Darwinian trend, some fundamental changes are beginning to appear in the PCB market: new technologies, new manufacturing philosophies and new exchange rates are redefining the rules of the game.

As the market improves in the latter part of 1987, the first signs of the success — or failure — of strategic plans that were made in 1985 and 1986 will appear. Strategies for survival differed markedly: some companies diversified; others consolidated; and those that could do so, invested heavily in capital equipment.

Certain catalysts promise to speed up the evolutionary process. Just-in-time manufacturing and surface mount technology are key components in the growth algorithm of PCB vendors and will play important roles in survival as the market begins to improve. The upshot is that the barriers to entry are getting higher. Production is now more capital intensive and long term vendor-customer relationships are becoming more popular as just-in-time sourcing takes off.

Most analysts that follow the printed circuit board market agree that the worst of the downturn is over. After plummeting from $5 billion in domestic production in 1984 to $3.9 billion in 1986, the market is showing signs of a rebound. Estimated at around $4.17 billion for 1987, average growth rates for the year range between 7% and 15%; a vast improvement over the contractions of the last two years.


1986 sales of board makers by company size

* Includes captive and merchant sales

Source: K-MA Marketbase Services

Although high single-digit growth is a welcome improvement, no one in the merchant board business is willing to bet the factory on the continuation of this upward trend. While vendors have been seeing both bookings and shipments improve since the beginning of the year, false starts have occurred before.

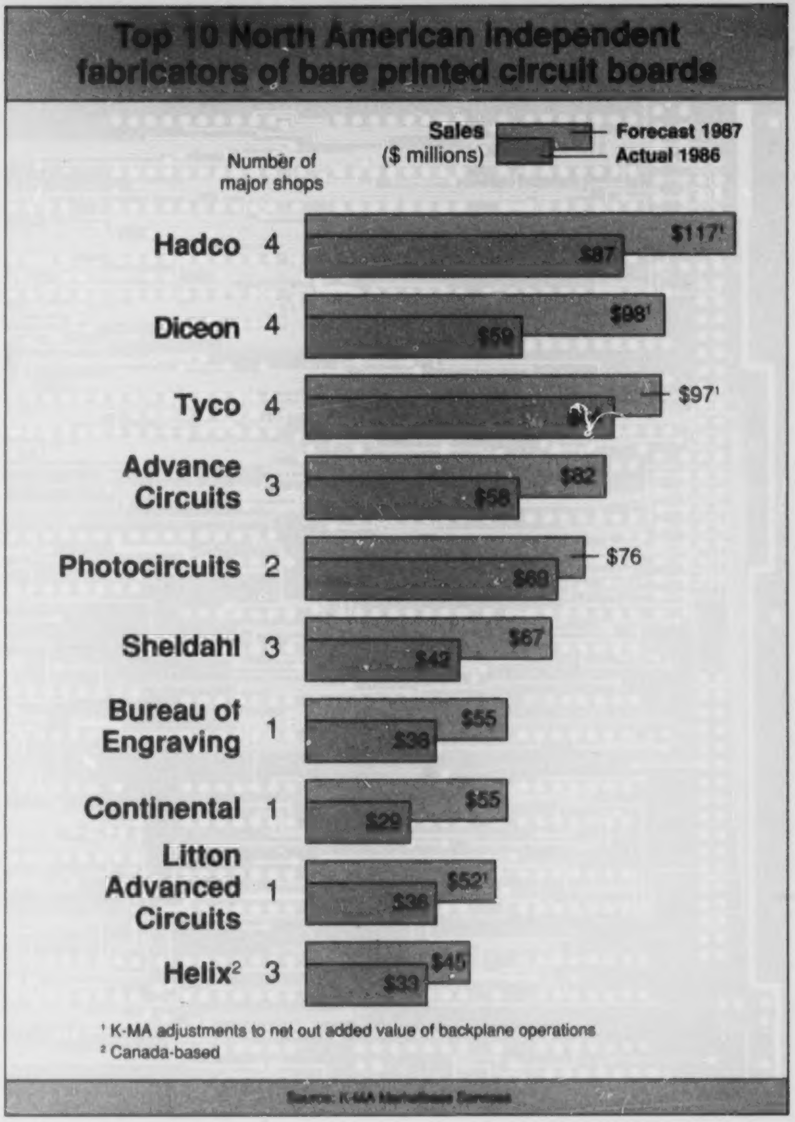
"I would want to see [the recovery] sustained for a little longer before I say that the turnaround is indeed here," comments William G. Weiler, president and chief executive of Toronto-based Helix Circuits Inc. Helix had sales of $33 million in 1986 but has not seen a profit for two years. Most of Weiler's competition is equally unwilling to say the recovery is real. Andrew E. Lietz, vice president for sales and marketing at top-ranked Hadco Corp., headquartered in Salem, N.H., says that given the ups and downs of the last few years, Hadco's management remains "cautiously optimistic."

While industry leaders wallow in skepticism, analysts are convinced that the recovery is real. They point to the comeback of the computer industry and the reduction of offshore competition, especially from Japan, as evidence that the board market is on the mend.

Market researcher Philip Lapin, president of Electronic Marketing Consulting of Redwood City, Calif., believes that this recovery is on a much steadier path than that which was exhibited in the early part of the decade. Lapin puts U.S. PCB production at $4.17 billion for 1987 and forecasts 12.2% growth to $4.68 billion for 1988. "This is a subtle recovery and that is probably much, much better for the industry than the roller coaster ride in 1983-84," he says.

But, although a return to health seems likely, few expect prices to rebound. The reason is that there is still a lot of overcapacity in both the merchant and captive markets, as well as stiff competition for market share from the plethora of companies. "I think there is a lot of competition out there, so I don't know if prices will be going up, but at least they seem to be stabilizing," says Vincent Gatto, executive of the printed circuit group of Tyco Laboratories Inc., a leader in the merchant business.

Gnostic Concepts Inc., a Menlo Park, Calif., market research firm, estimates prices for one-sided and two-


Top 10 North American independent fabricators of bare printed circuit boards

¹ K-MA adjustments to net out added value of backplane operations
² Canada-based

Source: K-MA Marketbase Services

sided boards to rise by a scant 3%, and only 5% to 7% for multilayer boards. Much of the increase is due to the higher cost of materials.

Harvey S. Miller, president of Kirk-Miller Associates, a Palo Alto, California-based market research firm that specializes in printed circuit boards, believes that capacity utilization in the United States has built from 70% during the recession to 85% this year. He estimates that, because $500 million in capacity disappeared during the past couple of years due to closures, demand and supply are now closer to equilibrium. Gnostic Concepts, however, claims that less than 70% of capacity is being utilized currently and will probably not reach much more than 75% by the end of the year. This jibes more closely with comments from top board makers.

Lower growth rates

Even though the astronomical growth rates of 1983 and early 1984 may never return, many PCB industry leaders agree with Lapin that the lower growth rates forecasted for 1987 and 1988 are better for business. With more stability, attention can be given to applications of new component technology, such as surface mount technology and, to a lesser degree, flexible and injection-molded boards. Instead of short-term crisis management, companies can concentrate on much needed long-term capital investment.

Lapin estimates that 40% of all boards produced in the U.S. market are destined for the computer market. Even though it is coming back slowly, the computer market represents a boon for board fabricators and assemblers. Similarly, he estimates that between 15% and 20% of all boards produced in 1987 in the U.S. market will incorporate surface-mounted components.

"Surface mount has been coming on very strong in recent months," claims Jonathan F. Kropper, president and chief executive of Hadco. Others in the industry agree that since orders for new designs started picking up at the end of the year, the demand for boards with surface-mounted components has been increasing steadily. "Eighty percent to 85% of what we are doing right now has a surface mount feature of some kind," says Michael Flatt, chairman of Continental Circuits Corp. of Phoenix, Ariz., a progressive company that grew 32% in 1986.

But Ray Pritchard, the executive director of the Institute of Interconnecting and Packaging Electronic Circuits (IPC), headquartered in Lincolnwood, Ill., the trade organization for the circuit board industry that claims 1,400 members worldwide, says surface mount is more talk than action at this time. "We get mixed signals about surface mount: everybody is interested but they don't all know how to design [the boards]." Until board designers come up to speed on surface mount technology, he says, sluggish growth will continue.

As surface mount catches on, Miller speculates that the relationship between the customer and the vendor will become closer. Higher levels of service and a closer working relationship will become necessary because the fabrication process is more complex than for the more conventional boards with holes. "That helps domestic sourcing," Miller comments. Instead of shipping board fabrication and assembly offshore, U.S. original equipment manufacturers will require their PCB makers to be close by.

The largest and fastest growing segment for 1987 and beyond will be multilayer boards. Gnostic Concepts estimates that MLB production in the United States will grow from 51% of the total, or $1.83 billion in 1986, to 56% or $2.64 billion by 1991, at a 7.6% annual growth rate. The highest growth will be in the flexible multilayer category.

Although still a very small part of the total PCB market at $317 million in 1986, Gnostic Concepts forecasts U.S. consumption of flexible boards will reach $449 million by 1991, averaging 7.2% growth annually. In 1986, only 12.3% of the flexible market was in multilayer boards, but by 1991, Gnostic Concepts estimates market share to reach nearly 20%. The annual growth rate of multilayer flexible boards will average 17.4% rate over the five-year period and grow from $39 million to $87 million.

Miller agrees that the flexible market will come on strong. Combining flexible and flexible-rigid hybrid boards, Miller puts the total size of the market at around $300 million in 1986, half merchant, half captive. Growth will be about 50% in 1987, he says, largely because of the growing number of applications in the commercial market that are using flexible boards.

Herbert W. Pollack, president of Methuen, Massachusetts-based Parlex Corp., maker of flexible and flexible-rigid boards, expects sales for fiscal year 1987, ended June 30, to increase by 25% over fiscal year 1986. Last year's sales came close to $30 million. The main growth in the flexible market, Pollack says, will be in the military area, where most of the flexible work historically has been done. The commercial market has not been tapped yet, he says, because it tends to much more cost sensitive than the military market. Parlex is concentrating on getting its costs down so it can compete with the commercial rigid market.

Total U.S. production of printed circuit boards

Merchant and captive production ($ billions)

	1985	1986	1987	1988	1989
Multilayer					
4-8 layers	$1.42	$1.34	$1.46	$1.67	$1.89
Over 8 layers	0.16	0.15	0.16	0.19	0.21
Premium boards*	0.27	0.27	0.32	0.38	0.45
Double-sided	1.31	1.18	1.31	1.46	1.59
Single-sided	0.18	0.18	0.19	0.20	0.21
Flexible	0.35	0.40	0.45	0.50	0.54
Paper-mat-composite	0.22	0.24	0.27	0.29	0.31
Total	**$3.91**	**$3.76**	**$4.17**	**$4.68**	**$5.21**

Totals may not be exact due to rounding

* Specialized laminates: polyimide, high frequency and other specialized resins

Source: Electronic Marketing Consulting

David Becker, manager of marketing and development at the Northfield, Minn., flexible circuit division of Sheldahl Inc., a leader in flexible board fabrication with $62 million in sales for the fiscal year ended in August 1986, says that 80% of the output from the Northfield facility goes to the commercial market. Customers include companies like AT&T, Ford Motor Co., Hewlett-Packard Co. and IBM. Both HP and IBM are important customers for the growing surface mount market, says Becker. Surface mount accounts for between 30% and 50% of all products, he claims.

Becker expects growing demand from the automotive industry over the next five years. "Weight and space are the factors that fit hand in glove with what flex does," he says, referring to automotive applications. In total, Sheldahl expects 10% to 15% growth in 1987. While flexible circuit boards will replace a small percentage

The polarization of PCB companies

For years the printed circuit board market has been an industry for the masses. Companies pop up like mushrooms overnight, some survive and flourish, others wither and die. Only a handful of merchant vendors are of any respectable size. Now that business appears to be picking up, the battle for increased market share is heating up. The companies to suffer the most, analysts say, will be mid-sized shops.

It has been suggested that the PCB merchant market will soon look like the double humps of a camel: one hump for the many small board makers (below $5 million) catering to the regional market; and another hump for the few very large ($100 million plus) merchant companies that will produce the large-volume capital intensive boards. Ray Pritchard, executive director of the Institute for Interconnecting and Packaging Electronic Circuits (IPC), the trade organization for the PCB industry with some 1,400 members around the world, says that about 80% of the industry is made up of companies with sales of less than $5 million a year. The small shops are here to stay, he says.

The segment of the market to suffer the most will be those in the middle range. The companies that have 30 to 40 customers but are having trouble competing with the big boys because of the lack of capital investment. They must either find a lucrative niche and milk it for all its worth or they are doomed to being a "me-too" shop and will ultimately get lost in the shuffle.

According to PCB market analyst Harvey Miller, president of Kirk-Miller Associates of Palo Alto, Calif., the recent evidence indicates that the middle tier of board makers has been dwindling. "A lot of the casualties in the last couple of years have been in the $10 [million] to $25 million group," he claims.

Many in the industry think this polarization trend will continue and will be made worse by another dip in business. Jack Mettler, president of Circuit Wise Inc., a $30 million North Haven, Connecticut-based PCB maker, puts it succinctly: "The guy who is doing $15 million with 40 customers is going to get cut up by the big guys and the little guys."

Keith Robbins, vice president of Photocircuits Corp. of Glen Cove, N.Y., a leveraged buyout from Kollmorgan Corp. in late 1986, believes that the worst of the shakeout is over but the trend to rationalize will continue. "There will be some fallout of the medium-sized shops — $10 [million] to $20 million — and the larger shops will continue to grow," he claims. Robbins speculates that the small shops will show resilience in the feast-or-famine PCB market because they can always find quick-turnaround and prototype business. ☐

of rigid boards in the future, most of the flex business will come from new applications.

Another new technology that is creating brand new applications is the injection-molded, or 3-D board. Although 3-D boards have potential in many applications, ranging from computers to automobiles, they have not yet caught on. So far, the major players in the 3-D market are chemical companies like E.I. du Pont de Nemours & Co. and ICI Americas Inc., both of Wilmington, Del., which have the plastics technology. But some PCB companies are also involved.

Last year, Circuit Wise Inc., of North Haven, Conn., a $30 million board maker, set up Mint-Pac Technologies Inc., a 50-50 joint venture with General Electric Co., aimed at high-volume applications of 3-D boards. Jack Mettler, president of Circuit Wise, says that so far, Mint-Pac is six months behind its planned sales schedule. The reasons include the extensive testing needed before bringing the product to market and the general reluctance of OEMs to accept change and employ the new technology.

Captive versus merchant

While companies like AT&T, HP and IBM maintain internal board shops, most of these big users also farm business out to merchants. Merchants, as a rule, claim to be more cost effective than captive shops and, in some cases, captives have cut back on their internal production. A case in point of a captive that opted to do more business outside is Unisys Corp., which recently closed two plants and will rely on the merchant market to supply an estimated $50 million in boards.

One beneficiary of the Unisys decision is the Bureau of Engraving Inc., a Minneapolis-based board maker. Sales for 1987 are expected to top $55 million, up from less than $40 million in 1986, says Darrell Chayer, vice president and sales manager for the Bureau. With top management changes and a high-tech niche carved in the four- to 22-layer board market, Chayer says the Bureau expects more business from Unisys as well as its other top customers, Digital Equipment Corp. and IBM.

But analyst Miller is quick to point out that Unisys is not initiating a trend. Instead, captives are attempting to spruce up their board shops to force them to stand on their own

Different strategies for the same goal

During the downturn, the leading merchant printed circuit board makers invested heavily while trying minimize their losses. Here is a summary of what three of the top 10 did to survive:

Hadco Corp. A few years ago, 50% of Hadco's business was with three customers: Digital Equipment Corp., Storage Technology Corp. and Wang Laboratories Inc. Because of tough market conditions faced by all three customers, Hadco suffered severely in 1985 and 1986, posting a net loss for the fiscal year ending Oct. 25, 1986 of a record $9.7 million. The company expects to return to profitability in fiscal 1987. The reason, says president Jonathan Kropper, is that Hadco's customer base has been diversified. "So if one customer catches a cold, we don't get pneumonia," he says. The result is that in 1986, Hadco had 26 customers that did over $1 million in board business.

Simlarly, Hadco has penetrated the European market with a highly automated facility in Ireland that will come on line by late 1988. And as Hadco looks to the future, Kropper anticipates "a significant opportunity" in the Pacific Rim. Currently, the company only has an agent in Hong Kong. "Simply stated, our strategy is to be in the market where our customers are located," says Kropper.

Continental Circuits Inc. At No. 8 in the lineup, 16-year-old Continental, a privately held Phoenix, Ariz., board maker, has been a shining example of how to run a board business through a downturn. Throughout the downturn, Continental has been profitable and between 1985 and 1986, the company grew sales at a 32% rate, says company chairman Michael Flatt.

The secret to Continental's success, says Flatt, was that in 1983-1984 the company positioned itself to focus on surface mount products. "We had something to offer that few people had," he says.

In an industry that is running at around 70% capacity, Flatt claims to be up in the 90% range. He says that sales will grow at an 83% rate in 1987 and will reach $53 million, up from $29 million in 1986. Since 1984, the company has increased its total floor space from 31,000 square feet to 75,000 square feet.

The most radical characteristic of Continental's strategy has been that it has no internal marketing or sales people. Since 1977, all the marketing is done by Jarko and Associates located right next door. "It is such a unified effort and has served us well in the downturn," comments Flatt.

Helix Circuits Inc. Through the downturn, 10th-ranked Helix expanded into four locations, two in Canada and two in the United States. The company closed its Montreal facility in June and moved most of its equipment to its Toronto headquarters. Because of the cost of capital expenditure, management decided to consolidate the two Canadian facilities, says William G. Weiler, president and chief executive of the company. Now, the company is concentrating on having one very strong division in Canada and two strong divisions in the United States: one in Irvine, Calif., purchased in April of 1985; and another in Woonsocket, R.I., that was recently completed. Plant capacity totals 141,000 square feet and business is divided 25% military and 75% commercial. Customers include the likes of Digital Equipment Corp. and IBM.

Because of the expansion, Helix posted record losses of $13 million for 1986 on sales of $33 million. But if the turnaround holds, Helix expects to return to profitability in 1987. "We feel pretty confident about profits in the short term and the long term," says Weiler.

Capacity is running at 60% of a total $120 million at this time because the Woonsocket facility is just coming on line. As for further expansion, Weiler says that stage is over for now. "We are in pretty good shape right now," he boasts. He expects the company will be profitable in 1987. □

and compete in the open market with the merchant board makers. Hewlett-Packard, a large captive board maker, is moving to make its board shop compete more efficiently for internal customers' business, Miller says.

More dramatic, and more relevant to merchants, is Tektronix Inc.'s printed circuit board division in Forest Grove, Ore., that is taking a bold step into the merchant marketplace. Miller estimates that Tektronix does about 25% of its business with outside customers.

Gene Hendrickson, general manager of Tektronix's PCB facility, says that top management made his division a profit center because of its excess capacity and its favorable cost competitiveness. Hendrickson says he intends to get up to a 50-50 mix of inside and outside business. The division's merchant share doubled in 1986 and will increase by 80% in 1987. "The importance of the customer has nothing to do with their name," he adds.

An embedded threat

While captives invade merchants and merchants invade captives on this continent, the international competition is eyeing North America hungrily. But, because of a weakened dollar, offshore competition has lessened over the past year. At the same time, the rate of offshore migration by U.S. companies looks to be slowing and just-in-time manufacturing and surface mount boards are demanding higher quality and closer relationships between customers and board vendors. All of these factors imply better conditions for onshore merchants. "I think the tide has turned," says analyst Miller.

But there is more to the picture than the importation of bare boards for use in U.S.-made products. The real threat to domestic board makers comes from embedded boards — those boards, manufactured offshore and stuffed into foreign-made goods for sale in the United States. While bare board imports in the U.S. market amounted to $322 million in 1986, the embedded board imports for the same period were nearly $900 million, Miller estimates. Even though almost half of these embedded boards were one-sided, a growing percentage of them are two-sided and multilayer boards.

Sources of PCBs imported into the U.S. market in 1986

($ millions)

	Embedded[1]	Bare boards
Multilayer	$128	$31.6
Double-sided	355	98.3
Single-sided	412	191.6

[1] Much of the embedded importation comes from Canada

Source: K-MA Marketbase Services

The main threat from embedded imports is the Far East; primarily Japan and the four Tigers — Taiwan, Hong Kong, Singapore and Korea. Miller estimates that between them, these five countries account for nearly 90% of all embedded boartd imports. With the value of the Japanese yen skyrocketing, the threat from Japan is abating somewhat. But with the four Tigers' currencies tied to the dollar, these countries still maintain a competitive price advantage in finished goods.

Keith Robbins, vice president of fifth-ranked Photocircuits Corp., a Glen Cove, N.Y., board maker, says that because of the falling dollar, he is seeing a little bit of an improvement relative to Taiwan and Japan. One indication of this, he says, is that old customers that disappeared two years ago are now reappearing because U.S. pricing is competitive.

Tektronix's Hendrickson agrees that conditions are improving because of the exchange rate, but insists that is no reason for U.S. PCB makers to rest on their laurels. Taiwan, he says, is the biggest threat: it has excellent capabilities, the country has been investing heavily and its people are well educated. He adds that Japan would be a major threat if it were not for the exchange rate. "In the last two years, [the Japanese] have doubled their circuit board manufacturing capability with the most sophisticated automation systems in the world," he says. A clear indication that they are not about to give up the fight for U.S. market share.

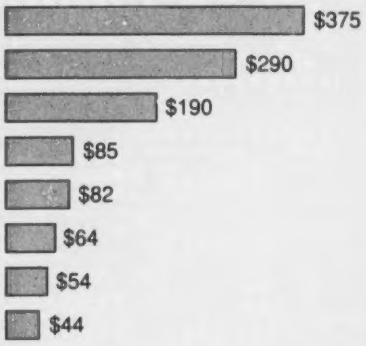
As for the European market, there is little penetration into the U.S. market from that part of the world, and equally little import from the U.S. Hadco has a presence in Ireland and IBM has a facility in Stuttgart, West Germany, says Roger Tyler, senior consultant with BPA Ltd., a market research firm in Britain, with a U.S. office in Cold Spring Harbor, N.Y.

Hadco's president Kropper says that Ireland was chosen because "we have a number of customers moving to Europe and we believe that we

Top 10 U.S. captive fabricators of bare printed circuit boards

Internal fabrication, not total usage

	Number of major shops	Percentage merchant sales	Forecast 1987 sales ($ millions)
IBM	3	0%	$375
AT&T	3	5%	$290
GM Hughes	6	7%	$190
Hewlett-Packard	4	0%	$85
GE/RCA	5	0%	$82
DEC	2	0%	$64
Rockwell	2	49%	$54
Tektronix	1	25%	$44
Cray	1	0%	$38
Unisys	2	0%	$35



Source: K-MA Marketbase Services

ought to be there to service them." The facility will come on line by late 1988, will produce multilayer boards of "higher technology" and will operate on a stand-alone basis. "We believe it will be one of the premier facilities in the world, technologically speaking," boasts Kropper.

JIT anyone?

But in this day and age, technology is not everything. As analyst Lapin points out, the PCB market is largely a service business. Without on-time, quality deliveries, technology counts for naught. As capacity utilization increases and competitive hackles are raised, the merchants that can differentiate themselves by service will be the ultimate survivors. Comments Steven Fadler, vice president for marketing at the Advanced Circuitry Division of Litton Systems Inc., a Litton Industries Company in Springfield, Mo.: "It used to be that comments were made that [JIT] was a trend for the future. I think right now it is more and more becoming a matter of daily happenings."

All of the top players in the merchant market claim to be participating in some just-in-time programs with their suppliers. JIT refers to inventory arriving on the production floor just in time for production and involves a commitment to total quality in the sourcing and manufacturing of products.

One component of JIT that is affecting most board makers is the whittling down of the number of suppliers and the setting up of cooperative long-term relationships. Many have been reviewed by their customers over the last year or so. Some have lost business and others have picked it up. In this way, JIT is contributing to the natural selection process of quality fabricators and assemblers.

Most vendors that have the automation equipment and the resources for quality control education, such as statistical process control, are able to participate in JIT programs. The pressure is greatest for the smaller companies that do not have the funds for such tight quality control. ☐

Materials market: An upward movement

The materials market that supplies the printed circuit board industry is not an area of great volatility. Controlled by giants like E.I. du Pont de Nemours & Co., ICI Americas Inc. and Dow Chemical Co., there is little boat-rocking. Only when it comes to new technologies, particularly surface-mounted components and injection-molded boards, is there any flourish of activity.

Both the quantity and price of materials — laminates, resins and chemicals — are expected to show some slight upward movement in 1987. According to Richard Avins, a consultant with Strategic Analysis Inc. (SAI) of Reading, Pa., the total market will grow from $1.25 billion in 1986 to $2.3 billion by 1991 at an average annual growth rate of around 14.5%. Resins, used to make laminates, will increase in price in the order of 5% to 7% while chemicals and other materials should post price increases of 13%, he says. Gnostic Concepts Inc., a Menlo Park, California-based market research firm, agrees with SAI that material costs will increase gradually but steadily in 1987.

The first six months of 1987 have been pretty flat but Avins expects more robust activity in the second half as board makers begin to benefit from the rebound of the computer industry. Avins expects growth for 1988 to be in the order of 11%.

Prices of materials are firming up but price rises are not in the cards, says Joseph P. McGonnell, business director for Du Pont's printed circuit materials division. "At this stage, business looks pretty strong and volumes are beginning to rise," he says. Partnerships between the materials supplier and board makers are also becoming more common as the technology advances. With the finer lines, more layers and demand for higher quality and functionality, the material people become more critical, says McGonnell.

Most material makers accept that surface-mounted (SM) components will soon be the norm and they are gearing up to supply the materials for this market. Du Pont, a leader in imaging products, resins and cleaning chemicals, is looking to be a one-stop shop for all PCB makers' material requirements, both fabrication and assembly. "Assembly is clearly going to surface mount," says McGonnell, "and that affects not only the assembly but the way you construct a board."

U.S. consumption of materials and laminates

($ millions)

	1986	Forecast 1991
Materials		
Chemicals	$322	$592
Castings	140	258
Imaging materials	60	110
Total materials	**$522**	**$960**
Laminates	$730	$1,342
Total	**$1,252**	**$2,302**

Source: Strategic Analysis Inc.

As SM catches on, the demand for thermally stable resin systems will grow because as the population of devices on the board increases, the board itself needs to withstand higher temperatures during soldering. But even though these resin systems perform better than the common fire-retardant resin, FR4, used in most boards today, FR4 is still preferred because of its lower price.

Although injection-molded boards are a good idea, the market for them has not yet materialized. But that has not prevented Du Pont, General Electric and ICI from investing in the technology. Strides have been made in the last year that have brought the injection-molded boards closer to marketability, says SAI's Avins. But problems still exist in the surface mounting of components and the workability of high-temperature resins.

ICI Americas bought out LNP Engineering Plastics, a material supply company in Malvern, Pa., two and one-half years ago. LNP sells two high-temperature resins into the injection molding market that are expected to replace FR4. George Forczek, market development manager at LNP, says it is a growing market, particularly in telecommunications, military and automotive areas. ☐

SURFACE MOUNT

PCB makers face rising demand for SMT

What began quietly 10 years ago as a new manufacturing method is now a way of life in the printed circuit industry

By Valerie Rice

Surface mount technology (SMT), the province of consumer electronics manufacturers for the last 10 years, may just now be hitting its stride in mainstream semiconductor applications.

Some analysts say SMT — which involves soldering components directly onto a board instead of the through-hole technique (pushing the leads of each component through the board) — could account for 20% of the total semiconductor market by the end of this year. Others predict a figure of 37% by the end of the decade. By comparison, the Japanese have between 50% and 60% of their market in surface mount, primarily because of their strength in consumer electronics. In any case, watches — until now the biggest application of surface mount technology — will step down sometime soon, leaving the way clear for computers, defense systems and even automobiles.

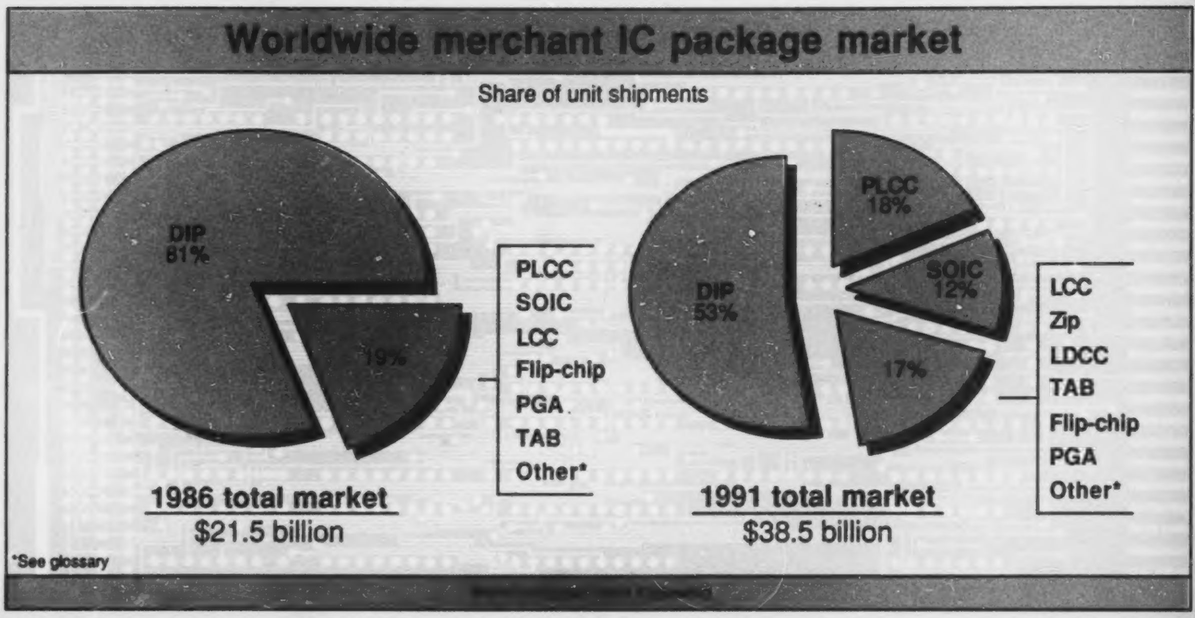
The customer is always right

"There's one primary reason we are doing surface mount technology," says Linear Technology's product marketing manager Robert Scott, "because customers are asking for it."

And customers are asking for it because it gives them distinct advantages in several different areas. SMT offers more functionality on a smaller board area. The smaller the board area, the less it weighs. In addition, the obvious space savings, combined with the other advantages, allows companies to create new products never before possible. For example, handheld televisions could not have been developed without surface mount.

"You couldn't do an embedded [disk] drive without SMT," adds Adaptec Inc. president John Adler. Adaptec, which does both chip design and sales, and board manufacturing, is in a unique position to leverage its SMT expertise. According to Adler, the company has done a "180° turnaround on surface mount. We do what our customers want. Customers are coming to us and saying, 'We want to buy in plastic leaded chip carriers [PLCC]. When can you ship it?' I'd be hard pressed to find any shipments we're doing today in through-hole, and in a year from now or less, we'll be totally out of the through-hole area." [There are several types of surface mount packages including plastic leaded chip carriers (PLCCs), leadless chip carriers (LCCs), small-outline integrated circuits (SOIC) and tape automated bonding (TAB).]

Lynn Crawford, advanced manufacturing director at Connor Periph-



Worldwide merchant IC package market

erals, explains the advantage that SMT offers his company: "We can get more circuitry per square inch by utilizing SMT. It would be impossible for us to offer a disk drive with a controller without SMT."

One of the driving forces behind SMT has been the personal computer marketplace, with its push toward smaller footprints and increased functionality. SMT, with its reductions in size and weight, is the perfect solution. According to Texas Instruments Inc.'s SMT development manager Charles Hutchins, SMT allows two to four times the amount of memory to be placed in the same space as compared with through-hole packaging.

Using SMT equipment technology, boards can be put together at an unheard of rate, says Signetics Corp.'s SMT marketing manager Mark Carsten. An average-priced SMT pick-and-place machine will turn out half a million boards per hour, he says, in contrast with a through-hole machine, producing between 20,000 and 50,000 boards per hour.

The amount of equipment needed to manufacture SMT boards is also less than that of through-hole boards, according to Thomas Dunne, president of Phase 4, a Phoenix-based manufacturers' representative.

Therefore it is not surprising that several high profile product announcements this year — COMPAQ Computer Corp.'s new gas plasma display screen and IBM's new PS/2 — are taking advantage of SMT. Peripherals companies, such as AST Research Inc. in Irvine, and Hercules Graphics in Berkeley, Calif., are rushing to take advantage of this market with SMT devices designed to optimize these products.

Other applications for SMT are increasing as well. The military market, which demands that its products be small in size and weight, is moving toward SMT — as is the automotive market. Automotive companies were slow to catch on to SMT, but began two years ago using the mounting process in radios. Today, SMT has moved under the hood, as well as to flat-panel screen displays in the cabins.

Standardize or perish

One of the problems with all of this new development has been the lack of standards in SMT. With so many different packaging options, and so many different types of equipment, some industry players are feeling timid about entering the market without the assurance of long-term standards.

Darrell Paga, standards coordinator of the Semiconductor Equipment Materials Institute (SEMI) in Mountain View, Calif., says that he believes the industry "feels the lack of standards. The committees are backlogged, and it is hard to come up with a consensus opinion. It is hard to get anyone to agree."

Lack of standards is a problem for everyone, he says, primarily because it drives costs up. And costs go up for both customers and equipment vendors, when products and equipment aren't compatible, he says.

The standards issue is not a physical issue, but a design issue for Adaptec's Adler. "We spent a lot more time designing boards with decent manufacturing or yield in SMT than we did in through-hole. We redesigned the boards two or three times for high-yield manufacturing."

At Texas Instruments Hutchins says that standards in "evolving technologies are always a real concern." To offset that concern, TI must forecast carefully, because as Hutchins says: "If we aren't correct, we may develop tooling that's obsolete."

In addition to battles over equipment standards, there is currently discussion over which type of quad flat pack to use for the U.S. standard — the Japanese version which is metric and thin, or the U.S. version which is nonmetric and considered by some to be technologically superior because it is thicker. Quad flat packs resemble a plastic leaded chip carrier, but lack any of the standards surrounding PLCCs. One area of discussion currently is the lack of a consistent standard on lead spacing. Insiders suggest that the U.S. will adopt the nonmetric flat pack, leaving the Japanese and the Europeans with a standard of their own.

Other packaging standards are being discussed as well, Paga says, but they are hindered by the proprietary nature of many individual companies' packaging solutions.

Not surprisingly, no one is willing to say how quickly standards, both for packaging and equipment, will be set.

The equipment side

The advent of surface mount has created an entirely new industry for semiconductor equipment manufacturers. In fact, there was a Surface Mount Equipment Manufacturers Association (SMEMA) formed recently to address some of the standards issues for equipment manufacturers, as well as act as an informa-

A glossary of terms

DIP, dual in-line packaging, is a rectangular package with leads on two sides. Typically the leads are formed in a butted position.

PLCC, plastic leaded chip carriers, are four-sided square packages with leads on all four sides curling under the body of the chip.

LDCC, leaded chip carriers, are ceramic packages, similar to quad flat packs, and there is no lead standard.

LCC, leadless chip carriers, are ceramic packages with metal contacts instead of leads and the contacts do not extend beyond the body.

SOIC, small-outline IC, is a rectangular package with gullwing leads on the two longest sides.

TAB, or tape automated bonding, bonds the chip to the board by a strip of tape.

Flip chip or COB, chip on board, takes two forms. The chip can be bonded to the board and then wire bonded. Or the traditional flip chip approach can be used, with gold solder bumps on the chip contacts. The die is then flipped over to the board and soldered.

PGA, pin grid array, is a square package with typically 68 pins out of the bottom; it resembles a bed of nails.

Zig Zag single in-line packaging has leads out of one long side and is exactly the same as single in-line packaging except that every other pin is placed in the opposite direction.

Other methods include packages such as zig zag, other single in-line packages, and pad grid arrays, which are like pin grid arrays, but use pads instead of pins.

Source: Integrated Circuit Engineering

tion clearinghouse for SMT equipment producers.

Surface mount equipment is certainly selling well. According to Phase 4's Dunne, 70% to 80% of his business in the last 18 months has been SMT related.

In fact, Dunne says that SMT equipment manufacturers have an advantage over through-hole systems in terms of sales. SMT equipment is less expensive in the long run, Dunne contends, partially because with through-hole more machines are needed to get the job done and fewer of those machines are automated. A pick-and-place robot handles it all, Dunne says, as well as taking up less floor space. Further space reductions are possible, he says, because the boards themselves are smaller.

Price is not a major consideration for Dunne's customers, he says, indicating that his biggest obstacle is customer ignorance. "Many companies are reluctant to put pick-and-place systems in because of information that is one to two years old. Two years ago there were only 500 parts available in SMT, and in one year that number grew from 500 to 5,000. I'm not sure about the count now. But it is outdated information that keeps people from changing over."

Not quite perfect

SMT is not without its detractors, however. Despite its obvious advantages, the technology, which has been around 10 years or more in consumer electronics, has been slower to gain widespread acceptance in the market than originally forecast.

One major issue, according to Integrated Circuit Engineering market research manager William J. McLean, is reliability. "Some manufacturers want to see 10-year lifetimes on SMT," he says. "It's difficult to get reliable information because the products have only been around two to three years. There is a barrier because there is no history. You don't know if problems have been identified. You can only overcome that problem with additional time."

SMT is also relatively difficult to design, from a computer-aided design perspective, says Dataquest Inc. analyst Isadore Katz. "In general the pin spacing is not the same as the through-hole format," Katz says. "On a CAD system, a designer must have another decimal place in accuracy in terms of complexity. This slows everything down."

Another problem, Katz points out, is testing surface mount boards. "To test each of the boards individually, you have to add test structures on the board, the so-called clamshells. This is not a trivial problem."

Despite the difficulties, Katz says that a recent survey indicated that 26% of all boards designed by CAD systems contained some SMT.

SMT boards are also harder to rework, says Connor's Lynn Crawford. In other words, Crawford says, it is much harder to correct a mistake. "It is a slightly more difficult manufacturing process, but overall, these are incidental problems," he says.

At Adaptec, Adler says he must keep an eye on his engineers so that they don't "go wild when designing an SMT board. Not all components are available in SMT. You have to be careful not to specify a need that doesn't exist." □

Beyond surface mount

Some in the industry say that the next step in printed circuit board assembly will take the advantages of surface mount — the ease of placement and small size — and go one further, mounting chips on boards without the use of packaging. Charles Hutchins, SMT development manager for Texas Instruments Inc., calls this "bare chip mounting." The chip will be designed so packaging is not needed, and instead will be mounted directly on the board by solder, and then covered with a protective film.

The idea, Hutchins says, is simple. "Ten years ago silicon was very small when compared to the package. Today silicon is 50% of the package size, so it is not hard to see that 10 years out [from now] there will be no package, but just silicon."

Solutions such as "chip on board" or tape automated bonding (TAB), which have approximately 1% of the market now, will continue to gain market share. These mounting techniques are the first moves toward what Hutchins sees as a time when "silicon itself will be designed to be a standalone building block." □

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DEFENSE

Learning to cope with a budget-conscious Congress

Some analysts suggest only 3% to 4% growth this year and next, or zero growth in real terms for military electronics

By John Kerr

When defense contractors get together these days, it's not exactly party time. And as usual they're blaming Uncle Sam.

The gloom began a year or so ago as the Congress began to hack away at oversized defense budgets. It worsened last year when Washington saw fit to curb contractors' profits and also ruled that industry, not taxpayers, should bear the brunt of R&D costs on tomorrow's major weapons programs.

The result is arguably the toughest business environment military-equipment makers have ever known. "The overall outlook is not good," warns a market analyst at Hughes Aircraft Co. in Los Angeles. The stakes are higher and paybacks lower than ever before as a widening posse of regulators maneuvers defense contractors into increasingly competitive niches.

At least those are the blues that contractors are singing. According Paul Nisbet, an analyst with Prudential-Bache Inc. on Wall Street, the contractors are not faring as badly as they might want others to think. Figures from ELECTRONIC BUSINESS' top 50 list of defense contractors bears him out: Many have miraculously managed to increase earnings during the bad times.

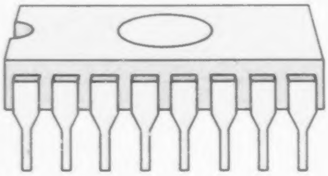
But the doomsayers' voices sing louder. The defense budget has also been hard hit by both deficit-nixing Gramm-Rudman legislation and by President Reagan's opposition to tax increases. A new report from Henderson Ventures, a Los Altos, California-based market research firm, forecasts that U.S. production of defense-electronics equipment will grow by only 4.4% this year, decelerating to a 3.6% pace in 1988.

Many analysts predict zero real growth in overall military-electronics revenue, stretching through 1990. Even formerly hot sectors like electronic warfare (EW) are stone cold. Only companies that have found the highlights in the no-growth picture — areas like command, control and communications, and integrated avionics — will manage to show respectable revenue gains.

Confirms Christopher Bernhardt, strategic planning director at the RCA Aerospace & Defense Group of General Electric Co. in Cherry Hill, N.J.: "If [a contractor] performs at an 8% a year growth rate he'll be doing well; if he grows 10% a year, he'll be doing phenomenally well."

"We are continuing to find procurements being stretched out," adds Gene Ray, president of Titan Corp., a diversified San Diego defense-electronics firm. Ray indicates that contracts are being awarded three to four months later than his most pessimistic projections.

Formerly hot sectors like electronic warfare are stone cold



Insult to injury

Adding insult to injury are new government mandates that keep tight reins on contractors' costs — and profits. The Department of Defense (DoD) and industry are squaring off over Navy allegations that contractors' profits from military programs far outweigh those from their comparable commercial work.

In its 1987 annual report, Logicon Inc., a Torrance, Calif., command, control, communications and intelligence (C^3I) firm, explains: "The DoD has developed a new profit policy to be used in negotiating defense contracts for solicitations issued after October 18, 1986. This new policy, if fully implemented in its present form, will result in generally lower negotiated profit levels on new contracts to which the policy is applied. It will mitigate any improvement in profit margins gained by lowering of tax rates."

The consequences are daunting. Some contractors report that their profits may take as much as a 30% knock. Others say that it may take twice as long to make the same return on investment.

The DoD is also losing friends with over zealous scrutiny of contractors' costs. In its eagerness to show Congress that it will never again allow contractors to bill for $600 military toilet seats and the like, the Pentagon — industry executives complain — is nickel-and-diming military-equipment firms to the limit.

Says Titan's Ray: "We've had audits for everything under the sun." Officials at Calabasas, California-based Lockheed Corp. tell of auditors checking on executives' hotel spending limits, and more. According to the American Electronics Association (AEA), one of its member companies has had 102 individual audits in the last year. Another calculates that the government spent $300,000 in auditing its overhead of $500,000. Often, reports the AEA, the same prime contractor will audit the same departments at one subcontractor via different programs. "It's a classic case of redundancy," says Jonathan Fleming, the AEA's senior manager of government procurement programs in Washington.

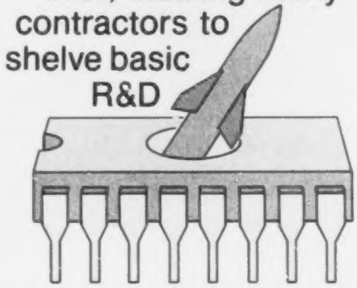
Ceding to the bureaucratic momentum behind the penny-counting, contractors are not optimistic about an early end to what they view as a wanton waste of their time and manpower. "It's something we're going to learn to live with," sighs one contractor. It seems so: the AEA claims that the Defense Contracts Audit Agency continues to recruit staff.

Making things more uncertain still is the ruckus created by the Competition in Contracting Act of 1985, another attempt by the DoD to make sure taxpayers get value for their money. The idea is that contractors will compete for major programs like the Advanced Tactical Fighter, with the most cost-efficient team winning the production work.

Although this is laudable in theory, it seems ludicrous to the defense industry. It means, some executives complain, that many contractors stake big bucks of their own on development, but only one team gets the payoff. And it is yet one more legislative roadblock for the industry. "Our biggest concern on profitability is the cumulative impact of all the reforms and regulations. It'll come home to roost in the 1989-1990 time frame," says GE strategist Bernhardt.

Military-electronics contractors are dealing with it in several ways. Many, like Honeywell Inc., are focusing only on markets that they feel they'll make money in; satellite maker, Detroit-based Ford Aerospace & Communications Corp. is concentrating on higher growth C^{3}I and tactical-weapons work. "We're having to be even more selective than before," says Donn Starry, Ford's executive vice president of its Washington operations.

Deciding where the investment dollars are to go is harder than ever, causing many contractors to shelve basic R&D



Other firms are bidding only on awards that they have a reasonable chance of winning and that they know will yield a proper return on the dollar. Hughes, now in General Motors Corp.'s fiscally conservative charge, admits that it bids with much less bravura than before.

Deciding where the investment dollars are to go is harder than ever. Many companies are now compelled to drop basic research in favor of more applicable studies. "You can't afford to do what I call hobby-shopping; R&D has to relate to projects on which you intend to bid," says Ford's Starry.

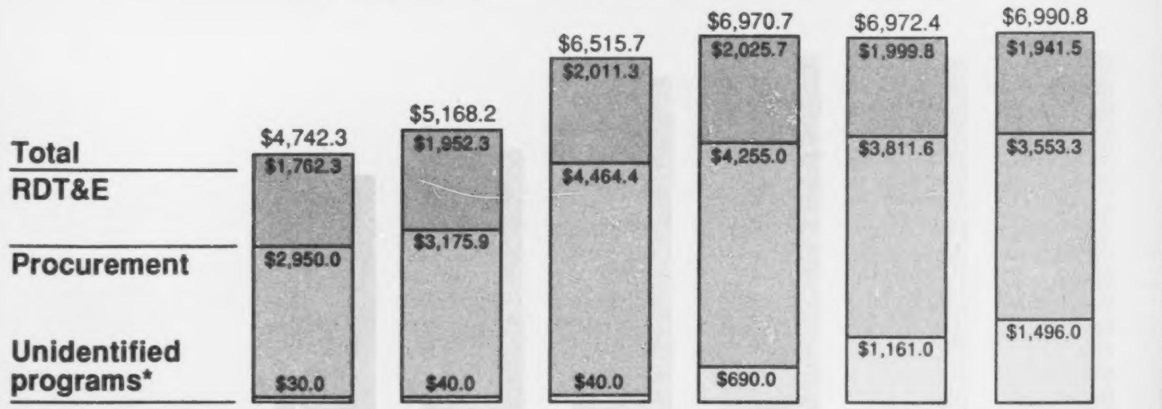
Critical mass

Contractors are also coping by consolidating, producing a marked restructuring of the industry. Where internal growth is not sufficient to achieve the "critical mass" needed to compete vigorously on key programs, acquisitions and mergers provide an answer. Seattle-based Boeing Co. bought out Sunnyvale, Calif., surveillance and countermeasures specialist ARGOSystems Inc. this spring, not long after EW supremo Loral Corp. of New York City took on Goodyear's aerospace and defense group.

Other moves include Chrysler Corp.'s $367 million bid for Texas C^3 specialist Electrospace Systems Inc., along with Beverly Hills-based Litton Industries Inc.'s purchase of Gould Inc.'s microwave products unit and of Harris Corp.'s solid-state microwave amplifier group. The restructuring will not stop there: giants such as Ford plan acquisitions. Meanwhile, companies like EW player Watkins-Johnson Co. of San Jose are

U.S electronics warfare appropriations

Fiscal year totals for all armed forces ($ millions)



* May be either RDT&E or procurement

Source: Frost & Sullivan Inc.

Top 50 defense electronics contractors

		Fiscal year figures					
Rank	Company	Defense electronics revenue ($ millions)	Total revenue ($ millions)	Total workforce	Defense electronics employees	Prime contract awards from the DOD ($ millions)	Fiscal year ended
1	**GM Hughes**	$6,120.0	$10,440.0	102,000	59,160	$5,069.3	12/86
2	**Lockheed ***	5,500.0	10,273.0	96,900	10,000	4,896.3	12/86
3	**McDonnell Douglas**	5,110.7	12,660.6	105,696	NA	6,586.3	12/86
4	**Raytheon**	3,888.0	7,308.0	75,000	40,000	4,051.6	12/86
5	**General Electric**	3,500.0	35,211.0	50,000	40,000	6,847.1	12/86
6	**Boeing**	2,900.0	16,341.0	125,000	13,000	3,556.0	12/86
7	**TRW**	2,670.0	6,035.9	78,556	27,408	1,052.6	12/86
8	**Westinghouse**	2,403.9	10,731.0	117,267	NA	1,713.2	12/86
9	**Rockwell**	2,368.0	12,295.7	121,000	20,000	5,589.7	9/86
10	**Unisys**	2,200.0	7,432.4	96,000	26,000	1,896.6	12/86
11	**IBM**	2,121.0	51,250.0	403,508	NA	1,359.2	12/86
12	**Grumman**	2,074.2	3,440.1	32,000	NA	2,967.5	12/86
13	**Litton**	2,069.0	4,521.0	55,500	20,000	1,663.3	7/86
14	**Martin Marietta**	1,901.0	4,752.5	68,500	15,000	2,935.4	12/86
15	**Honeywell**	1,800.0	5,378.2	78,000	NA	1,846.4	12/86
16	**Texas Instruments**	1,700.0	4,974.0	77,270	NA	1,434.9	12/86
17	**Textron**	1,609.0	5,023.3	72,000	NA	1,671.0	1/87
18	**Ford**	1,500.0	62,715.8	382,300	NA	752.1	1/87
19	**Singer**	1,370.1	1,725.2	28,000	23,600	985.8	12/86
20	**Allied Signal**	1,332.0	11,794.0	137,000	16,500	1,042.8	12/86
21	**ITT**	1,300.0	17,400.0	123,000	16,000	799.4	12/86
22	**Teledyne**	1,220.0	3,241.4	44,800	18,000	487.6	12/86
23	**General Dynamics**	1,200.0	8,892.0	105,400	NA	8,013.0	12/86
24	**Northrop**	1,200.0	5,608.4	46,800	NA	742.0	12/86
25	**Eaton**	1,052.0	3,811.6	43,000	9,285	1,068.1	12/86
26	**E-Systems**	1,050.1	1,145.5	15,000	13,270	192.1	12/86
27	**GTE**	936.9	15,111.5	157,000	NA	1,041.2	12/86
28	**Harris**	828.2	2,216.6	26,700	7,000	541.6	6/86
29	**United Technologies**	700.0	15,699.2	193,500	NA	3,527.0	12/86
30	**Loral**	634.0	663.8	8,100	6,480	377.0	3/87
31	**Magnavox**	565.0	665.0	8,880	7,605	NA	12/86
32	**Emerson Electric**	561.0	4952.9	60,700	NA	278.5	9/86
33	**Computer Sciences**	526.0	1,031.5	18,000	NA	288.1	4/87
34	**Motorola**	526.0	5,888.0	90,000	8,400	510.2	12/86
35	**DEC ***	500.0	7,590.4	76,860	NA	165.7	6/86
36	**Eastman Kodak**	462.0	11,550.0	121,450	NA	164.9	12/86
37	**EG&G**	450.0	1,145.1	23,000	5,000	NA	12/86
38	**Tracor**	441.4	632.1	10,500	7,400	193.7	12/86
39	**Gould ***	420.0	908.8	10,600	NA	300.4	12/86
40	**Wang ***	400.0	2,642.5	31,628	NA	NA	6/86
41	**Control Data**	341.6	3,346.7	34,409	NA	248.0	12/86
42	**ATT ***	300.0	34,087.0	316,900	NA	913.7	12/86
43	**Mitre**	271.9	362.5	5,500	NA	310.0	7/86
44	**M/A-COM**	255.0	577.5	9,027	3,100	NA	9/86
45	**Olin**	210.0	1,707.3	13,200	NA	306.6	12/86
46	**Varian**	205.0	891.1	11,600	NA	NA	10/86
47	**United Industrial**	201.3	272.5	4,050	NA	172.4	12/86
48	**Hewlett-Packard ***	200.0	7,102.0	81,000	NA	224.2	10/86
49	**Logicon**	196.5	198.4	2,456	2,456	NA	3/86
50	**Watkins-Johnson**	187.3	255.4	3,150	NA	NA	12/86

NA = Not available
* ELECTRONIC BUSINESS estimates

Source: ELECTRONIC BUSINESS

Notes on the top 50

ELECTRONIC BUSINESS each year ranks the top companies in defense electronics by contacting 150 leading defense contractors and asking them for their total revenue, defense electronics revenue, defense electronics employees and total employees. Many companies were forthcoming with the information; some were not. Much difficulty arises in obtaining numbers because a portion of each contract is often classified. (It seems that everyone has a Strategic Defense Initiative contract this year). Companies also often cite confidentiality agreements with the U.S. government as reasons for not breaking out their defense electronics revenue numbers.

However, not allowing a minor problem like nondisclosure to daunt us, ELECTRONIC BUSINESS picked over annual reports and pulled what numbers were available. In some cases we have gauged a company's 1986 defense electronics-related sales through estimates from Wall Street industry analysts.

Please note: No. 31, Magnavox Government and Industrial Electronics Co. (MAGIEC) is a wholly owned subsidiary of North American Philips Corporation. To qualify for high-level industrial security clearance for U.S. DoD contracts, MAGIEC's stock has been placed in a voting trust at the request of the U.S. DoD.

Overall, defense contractors racked up the usual billions in fiscal year 1986, but they have been hurt — or so they say — by the Gramm-Rudman-Hollings amendment which limits defense budget growth. Again and again in annual reports, companies cite changes in business because of DoD budgetary constraints and procurement policy changes. The effect of these changes on business means fewer new programs, increased competition for contracts, increased cost sharing for research and development, increased capital equipment investment and a higher level of unallowable costs.

Don't feel too bad for them, though. The top 25 contractors have defense electronics sales alone of over $1 billion.

NANCY MCSHARRY

considered good buys.

Another factor for participants to contend with is the growing internationalization of the business. U.S. firms now find feisty foreign defense contractors tackling them on home turf, and overseas markets closing off as others — notably Europeans — gain military-electronics expertise.

To keep overseas business alive, many U.S. firms are teaming with foreign counterparts. "The name of the game is collaborate or die," remarks Earl Washington, vice president for strategic marketing and international business at Rockwell International Corp.'s Electronics Operations in Anaheim, Calif.

Rockwell recently won a $500 million-plus award for submarine combat systems from the Royal Australian Navy. The deal was not one-way: Australia won jobs out of it, proving again that such "offset" agreements are increasingly central to international defense business. Last December saw one of the most obvious offset deals yet. Britain agreed to buy Boeing's E-3 early-warning aircraft, but only if it could gain 30% more value through technology transfer and jobs than it paid for the planes.

To keep overseas business alive, many U.S. firms are teaming with foreign counterparts

Although the odds seem stacked against military-electronics contractors, few are lining up for the soup kitchens yet. "If a company is looking at some area with a gleam in its eye, now's the time to go after it," explains Rockwell's Washington.

Besides, not every sector is belly-up. While contractors reliant on new aircraft and ship programs are eating dust, and even those building EW systems are tasting a slowdown, those working on missile programs and on C^3I fare better. According to market researcher Henderson Ventures, missile procurement is slated to increase by nearly 33% next year, while C^3I — a definite bright spot — will show an 8% boost in production this year and a 5.8% increase in 1988.

Antisubmarine warfare systems also remain hot. And although the controversial Strategic Defense Initiative, more popularly known as "Star Wars," did not win the funding this year that President Reagan had hoped for, contractors working on the development program still see good growth there.

TRW Inc.'s Electronics & Defense Sector in Redondo Beach, Calif., reports sound growth opportunities in integrated avionics systems for some of the newer aircraft platforms. TRW leads teams competing for the production phase of the Integrated Electronic Warfare System (INEWS) and the Integrated Communications, Navigation, Identification and Avionics (ICNIA) program.

Retrofitting work

Retrofitting work is becoming more and more of a factor in contractors' business plans as the armed services upgrade old equipment. But with increased scrutiny of the budgets, even some retrofit programs are slipping a bit.

Some of the strongest prospects for contractors lie in basic technologies — the semiconductors, sensors, software and systems-integration engineering central to every advance in defense-electronics equipment. Several players are watching with interest to see how Sematech — the consortium proposed as a DoD-backed chip-development resource — shapes up. One side effect may be sales of chemical vapor-deposition furnaces for use in semiconductor manufacture, which would benefit supplier Watkins-Johnson.

There also appear to be excellent opportunities for contractors adept at "black," or highly classified, activities. More and more defense-related work is disappearing underground: "The trend is still up," says one contractor. The Center for Defense Information, an independent Washington watchdog, claims that black defense spending is expanding: over $22 billion in the Pentagon's new 1988 budget is earmarked for black programs, a 16% rise over the record levels hidden in 1987 military plans where secret spending will top $19 billion, calculates CDI. ☐

COMPONENTS

Resistors: A reliable market nears $1 billion

The resistor manufacturers that have valued both quality and service are benefiting from an expanding market

By Carol Suby

The U.S. resistor market is expected to hover in the billion-dollar range for at least the next several years with U.S. consumption forecast to rise from $986 million in 1986 to $1.1 billion by 1991, according to research firm Gnostic Concepts Inc. in San Mateo, Calif. But, this minimal change in overall consumption cannot be equated with minimal change within the resistor industry.

This year issues such as quality and reliability and programs such as dock-to-stock and statistical process control have become the focus of major and not-so-major original equipment manufacturers (OEMs), says Gregory Littler, marketing manager for resistive products at Rohm Corp., an Irvine, California-based company that acts as a master distributor in the United States for Rohm Company Ltd. of Japan. Last year's just-in-time buzzword has given way to quality, service and communications, Littler adds.

These changes represent a part of an overall "renovation of American industry," says Lawrence Crum, director of marketing for Allen-Bradley's Resistive Products Division in El Paso, Texas. The total manufacturing culture has had to become more competitive, Crum points out. As a result, it's no longer "business as usual" in the resistor industry.

"Quality," Crum believes, "is the biggest single issue. [And] everyone's goals are the same . . . to get to zero defects." Moving in that direction, equipment manufacturers are setting acceptable levels of defective parts per million (ppm) for the components, including resistors, that they buy. And the margin for error is becoming increasingly thin.

Last year, AT&T was accepting resistors with defective rates of 200 ppm. That number has changed to 80 ppm for electrical defects and 100 ppm for visual and mechanical defects, according to Donald E. Gaddis, AT&T buyer of resistive devices, located at the company's Guilford Center Facility in Greensborough, N.C.

At GM's Delco Electronics Corp. in Kokomo, Ind., manager of purchasing John Stark says that the quality level of the surface mount resistors he receives is so high — averaging under 10 ppm — "we have found that we do more harm than good by conducting incoming inspection."

Service via communication

After quality, service has become the second new commandment in vendor/manufacturer relationships, and it usually comes in some form of communications. One of the fastest growing methods of communication between vendor and manufacturer — electronic data interchange (EDI) systems — are sprouting up everywhere, bringing the paperless office concept to the factory floor. These systems — used for order entry and acknowledgments, invoicing and, in some instances, for electronically transferring funds — generally consist of a network of personal computers and modems located at both vendor and customer locations. Third-party mailbox systems are used for transmitting the information.

Dale Electronics Inc. has EDI terminals at major customer and distributor locations. W.O. Means, corporate marketing director at Dale's Columbus, Nev., headquarters, expects the use of EDI systems will take off over the next two to five years, and believes that they will become, "the way to do business in the future."

In addition to changing how customers and suppliers communicate, the electronics industry is also overhauling its ordering practices. Contracts with guaranteed leadtimes are now giving way to release programs. A typical scenario, according to Rohm's Littler, might include a blanket two-year agreement that forecasts the need for a certain number of resis-

Nonlinears and networks are resistors' fastest growing segments

U.S. consumption of resistors by component type ($ millions)

	1986 value	Maket share	1991 value	Maket share	Average annual growth
Nonlinear	$137.4	13.9%	$233.5	20.1%	+10.2%
Network	184.6	18.7%	246.6	22.2%	+6.1%
Fixed	300.3	30.5%	325.3	29.3%	+1.6%
Trimmer	149.2	15.1%	153.5	13.8%	+0.6%
Potentiometers	214.7	21.8%	162.5	14.6%	-5.4%
Total	**$986.1**		**$1,111.4**		**+2.4%**

Totals may not be exact due to rounding

Source: Gnostic Concepts Inc.

tors. But the order would be filled in weekly, biweekly or monthly increments. And the number of units shipped each time would depend upon constantly updated forecasts provided by the customer.

For example, AT&T is currently putting into place its Business Resources Planning Program, which would provide customers with a long-range — approximately two year — planned order. Resistor vendors would then be provided with shorter term forecasts that would firm exact orders within eight to 10 weeks of shipping.

The fastest growth markets for resistors include communications and computers

U.S. consumption of resistors by markets ($ millions)

	1986 value	Maket share	1991 value	Maket share	Average annual growth
Electronic					
Government/military	$188.1	19.1%	$230.5	20.7%	+4.2%
Communications	148.9	15.1%	179.6	16.2%	+3.8%
Computer equipment	187.6	19.0%	224.9	20.2%	+3.7%
Industrial electronics	57.8	5.9%	67.6	6.1%	+3.2%
Consumer electronics	189.1	19.2%	215.2	19.4%	+2.6%
Business/retail/education	18.1	1.8%	18.2	1.6%	+0.2%
Instrument	107.7	10.9%	96.5	8.7%	-2.2%
Total electronics	**$897.4**	**91.0%**	**$1,032.0**	**92.9%**	**+2.8%**
Electrical/industrial	$88.8	8.9%	$78.9	7.1%	-2.3%
Total	**$986.1**		**$1,110.9**		**+2.5%**

Totals may not be exact due to rounding

Source: Gnostic Concepts Inc.

Vendor reduction

At the same time manufacturers are demanding better quality and service, they are also developing stronger relationships with a pared down number of suppliers. For example:

- AT&T, which bought approximately one billion resistors last year, buys 80% of those resistors from only a handful of suppliers, says AT&T's resistor buyer Gaddis.
- General Motor's Delco Electronics Corp., in Kokomo, Ind., uses no more than five vendors to supply in excess of 2 billion resistors a year, according to manager of purchasing Stark.
- Texas Instruments Inc.'s Industrial Systems Division in Johnson City, Tenn., has pared down its resistor supplier list to one preferred customer, according to TI buyer Suzanne Stacy. When "in a jam" Stacy will use other vendors. Otherwise, she prefers to purchase resistors from KOA Speer Electronics Inc., Bradford, Pa.

SMDs

Now that the computer industry is beginning to pick up and companies have more dollars to spend on capital equipment, the trend toward surface mount devices (SMDs) — leadless components that are placed on top of a printed circuit board rather than inserted — is back on track.

Although resistor manufacturers entered the surface mount arena at different times, all agree that SMDs will represent the major portion of their revenue some time in the 1990s. Last year, Bourns Inc.'s Network Division in Logan, Utah, was sampling its SMD products. Today, two surface mount network products are being offered with six-week leadtimes and another is in the prototyping stage, according to Bing Harding, president of the Network Division. In early 1986, CTS Corp., headquartered in Elkhart, Ind., introduced a surface mount resistor network. Since then, "production output has doubled, and redoubled," says James Long, national sales manager, at the company's Berne, Ind., facility. Although surface mount resistor networks represents less than 5% of CTS's total network output, Long expects that, "five years from now we will hit a crossover point where surface mounts will exceed leaded networks."

International Resistive Company Inc. (IRC was formerly TRW's Resistive Products Group) began pushing its broad line of SMDs two years ago. Boone, North Carolina-based IRC was the first company to offer surface mount wire wounds, according to Richard Paden, vice president, sales and marketing. Within the next two or three years, Paden expects surface mount will account for 35% to 40% of IRC's total revenue. Industry-wide, by the 1990's, "surface mount will probably account for half of all resistive components," predicts Dale's corporate marketing director Means. Dale has been offering a full catalogue of surface mount resistors since 1985.

Sprague Electric Co., which was first to introduce a surface mount capacitor, expects to be first again when it introduces a surface-mounted resistor/capacitor network by year's end, according to John Webb, marketing manager, thick film products at Sprague's Nashua, N.H., facility. Predicting a hefty growth rate of between 25% to 50% per year in surface mount networks, Webb expects that, by 1990, SMDs will account for 30% to 40% of total network demand. (Networks contain a number of resistors packaged into a single unit.) Currently Sprague, which has spent approximately $2 million gearing up for the manufacture of surface mount resistors, is "overwhelmed with demand for surface mount networks, but probably by the end of the year demand and supply will be in sync," says Webb.

For now, some manufacturers are facing surface mount delivery dilemmas. Texas Instruments' Industrial Systems Division just entered its first surface mount project which, this year alone, represents between 40 million to 50 million pieces. Also, "there are a couple of other [surface mount] projects coming down the pike," says buyer Stacy. Currently, however, Stacy says she is faced with leadtimes that she "cannot live with."

Meanwhile, it's a different story at GM's Delco headquarters. "Delivery to date has not been a problem and we don't expect it to become a problem," says manager of purchasing Stark. This is quite a feat for a company whose total surface mount requirement is in excess of 1 billion units a year. Stark attributes this smooth sailing to long-term planning that has been going on for several years with Delco's two surface mount resistor suppliers.

The winds of trade are shifting and those resistor vendors with domestic manufacturing are reaping a number of benefits. For some time, Far Eastern suppliers have been the price leaders in commodity resistors. But the rise of the value of Japan's yen in relation to the dollar — which has been averaging ¥140=$1 — is putting the squeeze on vendors with large manufacturing bases in Japan.

U.S. firm Stackpole Electronics Inc., has manufacturing bases in both Taiwan and Japan. When Stackpole was setting contract prices last year, the exchange was ¥205 to the dollar, says Stuart Tugman, vice president of marketing at Stackpole. By the third or fourth month that figure dropped to about ¥180, and the percentage difference was absorbed by Stackpole. This Raleigh, North Carolina-based company is now looking to move some of its metal film resistor production from its Japan facility to its Taiwan facility, which currently manufactures carbon film products, exclusively.

Perhaps hardest hit are Japanese firms such as KOA Speer Electronics Inc., the U.S.-based resistor operations for Japan's KOA Denko Company Ltd., which imports all of the resistors it sells from the Far East, 50% of them coming from Japan. Lester Rice, vice chairman of KOA Speer, describes the yen situation as "very serious" and says, half jokingly, that as a result of the yen's soaring value he is "almost half dead." KOA is looking to develop manufacturing facilities in mainland China, where exchange rates are a lot more controlled, according to Rice.

Indeed, on some spot purchases, Gaddis at AT&T is seeing some price increases — between 7% to 10% for Japanese firms and about 5% increases for some companies with American and/or European sourcing.

Such firming or rising of prices is only one indication that the worst is over for resistor manufacturers. Company revenues for 1987 are expected to increase by at least 6%, according to Tugman at Stackpole, to as much as 20% to 25%, according to Harding at Bourns and Thomas McKelvy, general manager, resistor operations at North American Philips' subsidiary Mepco/Centralabs in Mineral Wells, Texas.

Behind revenue growth is a resurgence of business within the computer and peripheral area, which is getting a boost from IBM's newly introduced Personal System/2 line of personal computers, suggests IRC's Paden. Meanwhile, Paden describes business from the automotive sector as "fairly steady." And the telecommunications sector, he adds, "has slowed down somewhat due to increased competition from European companies selling into the U.S. telecommunications market."

Orders from the military sector continue to be "fairly stable," according to Crum at Allen-Bradley, the primary supplier of carbon composition resistors to the military. □

Resistor makers restructure

Today, the resistor marketplace differs dramatically from what it was just three years ago, and key changes are expected to continue throughout the remainder of this decade. Resistor companies have been acquired, spun off, and, in some instances, acquired again. Analysts and vendors alike expect these consolidations to continue for some time, eventually leaving the industry with a handful of major suppliers with worldwide presence, and a smattering of small, niche-oriented companies.

The following list includes a number of companies that have experienced restructuring at some time during the past three years:

Allen-Bradley, Electronics Components Division, El Paso, Texas: In February, 1985, Rockwell International purchased Allen-Bradley Corp. for $1.65 billion. Even though there have been no major operational changes since then, Allen-Bradley's microelectronics operations, based in Greensborough, N.C., and the resistive products division, based in El Paso, Texas, have been consolidated into the Electronics Components Division, headquartered in El Paso.

CTS Corp., Elkhart, Ind.: During the fall of 1986, CTS was able to fight off an acquisition attempt by Dynamics Corp. of America by adopting a poison pill policy.

Dale Electronics Inc., Columbus, Nev. and **Vishay Intertechnology Inc.,** Malvern, Pa.: In 1985, Vishay formed a joint venture with a British investment firm, Mezzanine Capitol Corp., to purchase Dale Electronics for $93.8 million. The joining of Vishay — a $57 million company known for its high-end, precision resistors — with Dale — a $127 million company with a broad resistor product line and strong distribution channels — makes Dale/Vishay the largest fixed resistor company in the U.S.

International Resistive Company Inc. (IRC), Boone, N.C.: Acquired by TRW in 1968, and renamed TRW's Resistive Products Group, IRC was sold off in November 1986, and reclaimed its name. Crystalate Holdings Plc — a British company that also owns Welwyn Resistors — purchased IRC for $30.6 million. This sale not only broadens IRC's product line, it also increases the company's geographical market presence.

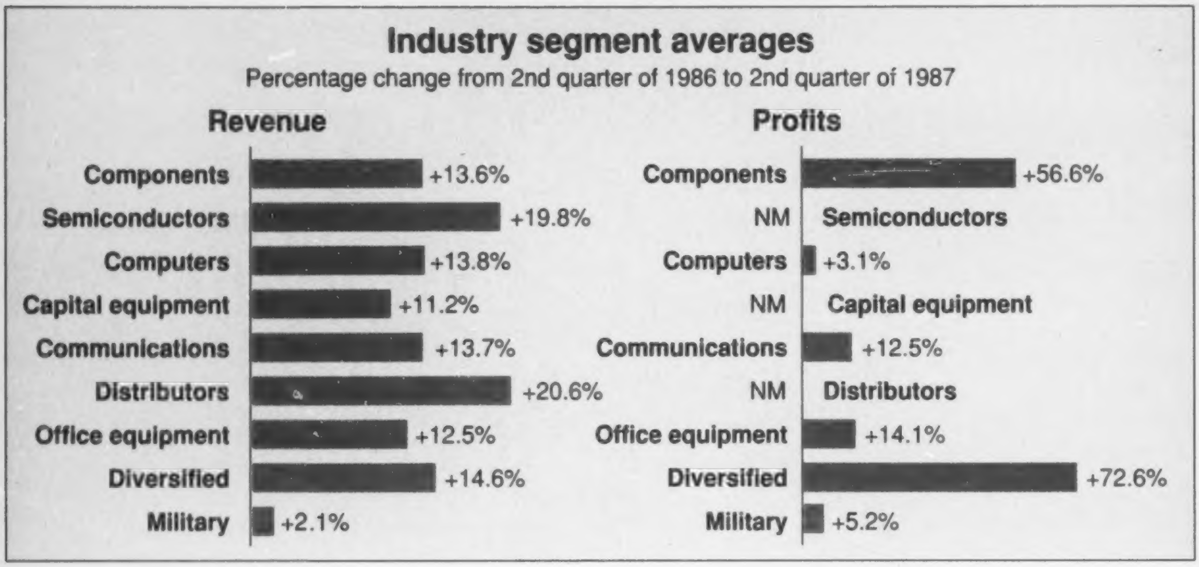
Mepco/Centralab Inc., Mineral Wells, Texas: Owned by North American Philips, Mepco/Electra, a manufacturer of passive components, was merged in March 1986, with Centralab, a manufacturer of capacitors and switches, as a part of N.A. Philips' move to consolidate many of its U.S. acquisitions. In June of this year another N.A. Philips subsidiary that manufactures resistors — Ohmite Manufacturing Company — was merged into Mepco/Centralab.

Sprague Electric Co., Lexington, Mass.: At press time, Sprague Electric Co. was in the process of being merged with another subsidiary, Solid State, renamed Sprague Technologies Inc., and spun-off from parent company, Penn Central Corp., Greenwich Conn.

Stackpole Electronics Inc., Raleigh, N.C.: Formerly part of the Components Division of Stackpole Corp. — a family-owned diversified company — Stackpole Electronics Inc. was sold off in August 1986, due to a family decision to pull out of the electronics industry. Charles Hill, company president, and several investors purchased the company for an undisclosed amount. □

QUARTERLY SCORECARD

Financial results of leading U.S. electronics companies



Industry segment averages

Percentage change from 2nd quarter of 1986 to 2nd quarter of 1987

	2nd quarter figures				Year-to-date figures				
Components (other than semiconductors)	Revenue 2nd quarter 1987 ($ millions)	Change from 1986	Profits 2nd quarter 1987 ($ millions)	Change from 1986	Revenue year-to-date 1987 ($ millions)	Change from 1986	Profits year-to-date 1987 ($ millions)	Change from 1986	Quarter ended
AMP	$585.9	19.0%	$62.5	47.8%	$1,111.7	17.6%	$116.7	53.6%	June 30
AVX	61.7	21.0%	3.8	NM	121.7	24.7%	7.3	NM	July 4
Augat	78.3	20.4%	2.8	0.4%	153.5	18.6%	6.4	39.6%	June 30
BRIntec	86.6	6.7%	2.5	-49.4%	167.0	5.0%	3.7	-55.4%	June 30
CTS	65.1	11.8%	2.1	NM	127.5	8.1%	3.6	NM	June 28
Kollmorgen	74.0	-17.9%	-2.1	NM	146.4	-16.4%	-2.4	NM	June 30
Segment composite	**$951.6**	**13.6%**	**$71.7**	**56.6%**	**$1,827.8**	**12.5%**	**$135.3**	**65.4%**	
Semiconductors									
Advanced Micro Devices	$192.4	25.0%	$4.1	NM	$362.5	18.0%	$0.8	NM	June 28
Intel	439.0	43.8%	46.5	NM	833.5	42.7%	55.0	NM	June 30
LSI Logic	59.9	24.9%	0.3	-66.5%	115.0	23.3%	2.4	-32.3%	June 28
Texas Instruments	1,371.6	10.2%	32.9	167.5%	2,643.5	10.6%	7.7	NM	June 30
Western Digital	140.3	59.4%	13.4	67.9%	262.3	59.5%	24.2	68.4%	June 28
Segment composite	**$2,203.1**	**19.8%**	**$97.2**	**NM**	**$4,216.8**	**19.2%**	**$90.1**	**NM**	
Computers, peripherals and software									
Amdahl	$341.0	62.9%	$31.0	1,044.7%	$659.5	61.0%	$56.2	996.8%	June 26
Apollo	132.2	49.6%	7.6	630.5%	255.6	50.0%	14.0	788.2%	July 4
Apple	637.1	42.1%	53.5	65.4%	1,212.4	41.4%	87.3	36.2%	June 26
Control Data	785.9	-5.1%	-5.6	NM	1,607.6	-1.0%	0.8	NM	June 30
Convergent	104.7	41.1%	0.1	NM	193.7	18.3%	-10.9	NM	June 30
Cray Research	124.9	-30.6%	19.6	-55.8%	339.1	5.3%	76.9	2.0%	June 30
Data General	313.6	-3.6%	-65.1	NM	628.8	-2.4%	-89.5	NM	June 27
DEC	2,669.1	22.7%	377.3	58.1%	5,079.1	23.8%	684.8	238.6%	June 27
IBM	12,798.0	4.3%	1,178.0	-9.7%	23,473.0	4.8%	1,963.0	-15.5%	June 30
Mentor Graphics	53.9	28.1%	4.7	107.9%	104.4	31.9%	8.9	113.3%	June 30
Micropolis	70.9	28.4%	6.8	53.3%	132.7	25.3%	13.0	59.0%	June 26
MiniScribe	80.5	84.2%	7.6	35.7%	141.9	68.7%	13.7	33.0%	June 26
Prime	236.0	12.1%	15.7	37.3%	457.8	12.4%	27.6	33.3%	June 30
Seagate Technology	250.1	76.7%	37.2	126.6%	517.1	92.6%	77.6	174.9%	June 30
Sun Microsystems	185.9	142.4%	10.9	98.1%	327.6	144.0%	21.1	137.3%	June 30
Unisys[1]	2,275.0	70.1%	121.2	59.1%	4,690.8	89.6%	231.4	151.0%	June 30
Segment composite	**$21,058.8**	**13.8%**	**$1,800.5**	**3.1%**	**$39,827.2**	**16.3%**	**$3,176.0**	**5.3%**	

NM = Not meaningful; company had a loss in the base year

[1] Last year's results were before the merger with Sperry

(Continued)

QUARTERLY SCORECARD

Financial results of leading U.S. electronics companies

	2nd quarter figures				Year-to-date figures				
	Revenue 2nd quarter 1987 ($ millions)	Change from 1986	Profits 2nd quarter 1987 ($ millions)	Change from 1986	Revenue year-to-date 1987 ($ millions)	Change from 1986	Profits year-to-date 1987 ($ millions)	Change from 1986	Quarter ended
Capital equipment									
Computervision	$136.5	14.4%	$1.4	NM	$276.4	19.0%	$2.4	NM	June 30
Fluke	51.0	-2.0%	2.6	-11.0%	103.5	-1.4%	5.2	-14.7%	June 26
GenRad	46.6	12.2%	-38.3	NM	94.9	15.0%	-39.7	NM	July 4
Teradyne	79.1	6.5%	-2.9	NM	158.1	5.7%	-6.8	NM	July 4
Varian	252.4	14.0%	4.3	NM	492.0	11.2%	8.2	NM	July 3
Segment composite	**$565.7**	**11.2%**	**-$33.0**	**NM**	**$1,124.7**	**11.2%**	**-$30.6**	**NM**	
Communications									
Andrew	$57.6	28.1%	$2.4	102.6%	$156.3	14.4%	-$5.4	NM	June 30
Avantek	52.2	6.3%	4.1	6.3%	103.0	11.3%	8.3	5.9%	June 20
Aydin	37.2	3.3%	2.4	23.2%	70.7	0.4%	4.3	16.0%	June 27
DSC Communications	77.2	-6.7%	2.9	-22.2%	154.0	-2.9%	5.3	-7.7%	June 30
Dynatech	82.4	14.8%	4.8	-20.9%	164.3	17.5%	9.3	-20.0%	June 30
General DataComm	49.4	5.1%	0.8	-26.8%	102.7	13.3%	2.5	64.0%	June 30
Northern Telecom	1,253.0	17.4%	77.6	19.6%	2,396.3	17.6%	137.7	19.7%	June 30
Paradyne	58.1	-13.5%	-1.5	NM	114.0	-14.4%	-3.9	NM	June 30
Segment composite	**$1,667.1**	**13.7%**	**$93.3**	**12.5%**	**$3,261.3**	**14.1%**	**$158.1**	**3.5%**	
Distributors									
Anthem	$46.9	67.7%	$1.2	38.0%	$91.3	62.5%	$1.9	11.0%	June 30
Arrow Electronics	150.5	14.1%	0.5	NM	294.7	13.6%	4.0	NM	June 30
Pioneer-Standard	57.7	11.9%	0.8	101.0%	115.0	13.0%	1.8	721.9%	June 30
Segment composite	**$255.0**	**20.6%**	**$2.4**	**NM**	**$501.0**	**20.0%**	**$7.6**	**NM**	
Office equipment									
NCR	$1,359.6	16.3%	$98.6	25.1%	$2,481.1	16.5%	$160.2	24.1%	June 30
Pitney Bowes	552.1	13.7%	44.6	17.2%	1,056.7	13.9%	85.6	16.8%	June 30
Savin	87.3	-8.2%	2.0	NM	176.2	-7.3%	3.5	NM	June 30
Xerox	3,600.0	12.5%	154.0	14.1%	6,950.0	16.0%	289.0	21.9%	June 30
Segment composite	**$5,599.0**	**13.1%**	**$299.2**	**20.2%**	**$10,663.9**	**15.4%**	**$538.2**	**24.9%**	
Diversified									
General Instrument	$280.1	79.7%	$12.0	344.4%	$521.0	65.2%	$18.8	120.0%	May 31
Gould	232.5	3.0%	5.9	-42.7%	460.1	1.3%	11.5	-53.6%	June 30
Honeywell	1,575.0	18.7%	54.3	24.0%	3,057.5	23.4%	98.0	22.2%	June 28
Motorola	1,639.0	9.3%	80.0	45.5%	3,185.0	12.2%	136.0	36.0%	June 30
N.A. Philips	1,066.2	0.2%	5.1	NM	2,171.6	3.8%	19.6	460.0%	June 30
Zenith	538.5	41.5%	0.3	NM	1,085.3	38.9%	1.3	NM	June 30
Segment composite	**$5,331.3**	**14.6%**	**$157.6**	**72.6%**	**$10,480.5**	**17.0%**	**$285.2**	**40.7%**	
Military									
E-Systems	$292.5	-3.0%	$10.3	-35.1%	$608.8	10.6%	$26.9	-11.1%	June 30
GM Hughes	2,622.8	-4.8%	140.8	5.9%	5,307.4	-0.1%	278.8	11.9%	June 30
Logicon	47.9	-4.7%	2.3	-4.2%	101.7	-2.1%	1.6	-68.3%	June 30
Loral[1]	317.8	108.2%	15.6	17.2%	532.5	47.5%	33.5	10.4%	June 30
Raytheon	1,917.0	4.9%	110.8	11.0%	3,668.0	3.2%	212.6	10.7%	June 30
Tracor	167.7	3.2%	7.5	0.2%	326.8	6.2%	14.8	-0.8%	June 30
Watkins-Johnson	62.4	-9.4%	3.8	-20.7%	128.5	0.7%	8.4	-9.5%	July 3
Segment composite	**$5,428.0**	**2.1%**	**$291.1**	**5.2%**	**$10,673.7**	**3.4%**	**$576.6**	**8.6%**	

NM = Not meaningful; company had a loss in the base year

[1] 1987 results include acquisition of Goodyear Aerospace Corp., now called Loral Systems Group

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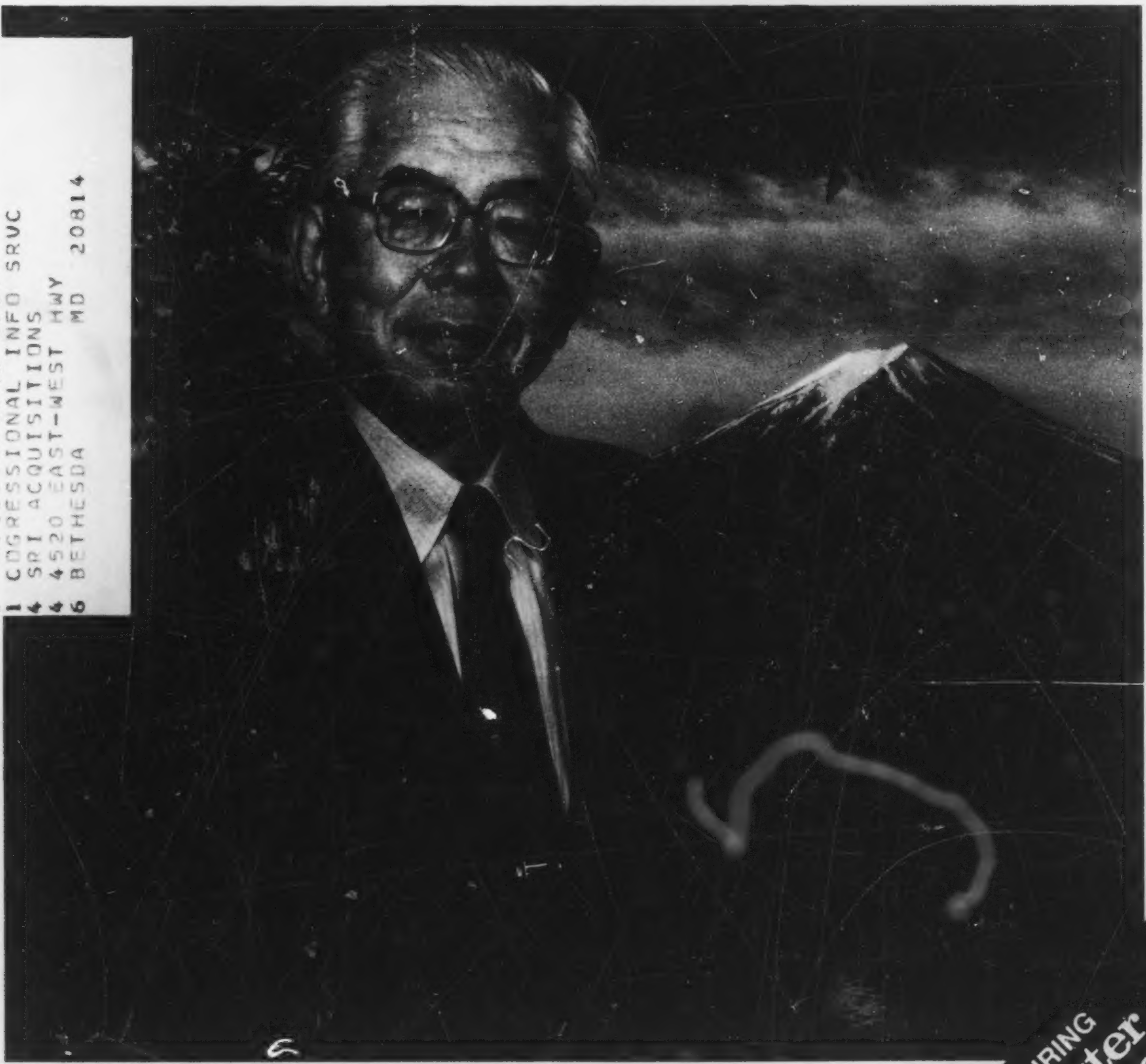

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SEPTEMBER 15, 1987

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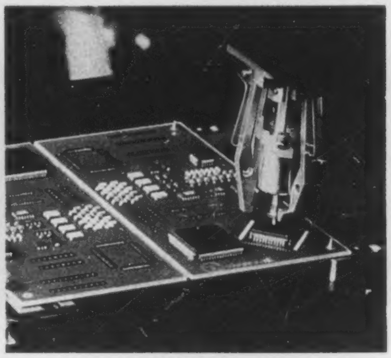

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Photograph of Tadahiro Sekimoto, courtesy NEC; background photograph, Mike Yamashita/Woodfin Camp

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BPA ABP

ASPCs: Teaching an old component new tricks

Application-specific passive components may do for passives what ASICs did for silicon chips

Managers of U.S. companies that make nonsemiconductor components of all types (capacitors, discrete semiconductors, ICs, magnetic components, resistors and others) have taken a page from their U.S. colleagues in the semiconductor business. They no longer expect much growth from their standard product lines. Instead, these managers look to add value to those products and solve applications problems for their customers; something akin to what application-specific ICs do in the semiconductor business. If successful, they look to expand their business by more than the 5% growth that the Electronic Industries Association is forecasting for this year in passive components.

After two years of declining and stagnating production of components in the United States, the application-specific component business provides a ray of hope. According to Federal Reserve Board data, the dollar value of U.S. production for SIC 367 (electronic components of all types, including semiconductors) peaked in the fourth quarter of 1984, almost three years ago. A year later, it had dropped by almost 20%, and it hasn't since picked up significantly. But in this quarter it may do so, according to the forecast by Cahners Economics. In fact, Cahners expects the second half to lift this year's SIC 367 production by 7% over 1986, and says it will end this year just short of the 1984 peak.

Although the FRB data does not separate semis from other components, most of the decline can be traced to U.S. semiconductor production. Likewise, semis are expected to bear most of the recovery. But the makers of nonsemiconductor components also saw their markets shrink, if not in units, certainly in dollars. Howard F. Wasserman, president of Unitrode Corp., a Lexington, Mass., company that splits its $150 million in sales almost equally between discrete semiconductors on the one hand; and capacitors, hybrid circuits and switching power supplies on the other; explains the price pressures on one of his passive components. U.S. suppliers of commercial axial-leaded ceramic capacitors, he says, "sold about the same number of units in the first quarter of this year as were sold in the first quarter of 1984. Yet, the dollar value of those units is less than 75% of what it was three years earlier."

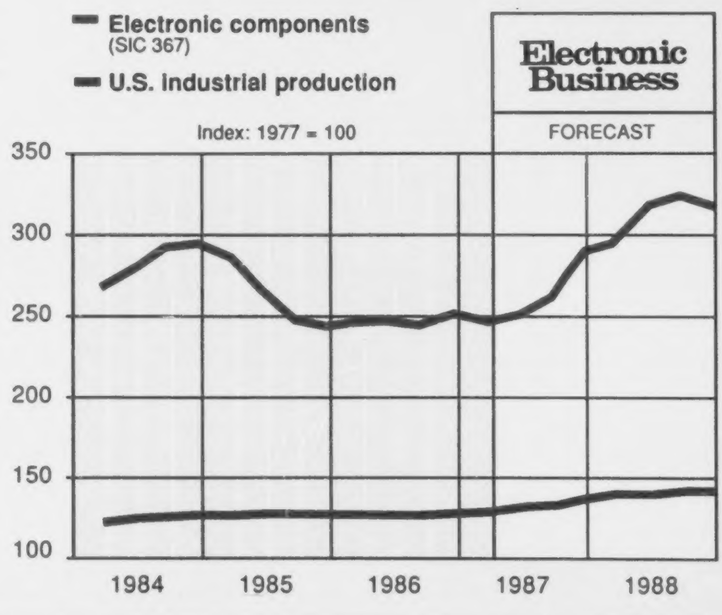
Wasserman wants to maintain market share in capacitor units, and hopes to even gain slightly in dollars by increasing quality and service. But he pins his hopes for growth on new products built around his current components but aimed at two applications: filters and switching power supplies.

AVX Corp., a Great Neck, N.Y., components maker whose sales of multilayer ceramic capacitors alone almost equal Unitrode's total revenue, is pursuing a similar strategy in the same markets. AVX's Olean Advanced Products Division, says chairman Marshall Butler, "sells filter components that allow AMP or Molex to take a $5 connector and make it into a $15 filter connector."

ALBERTO SOCOLOVSKY

Electronic components

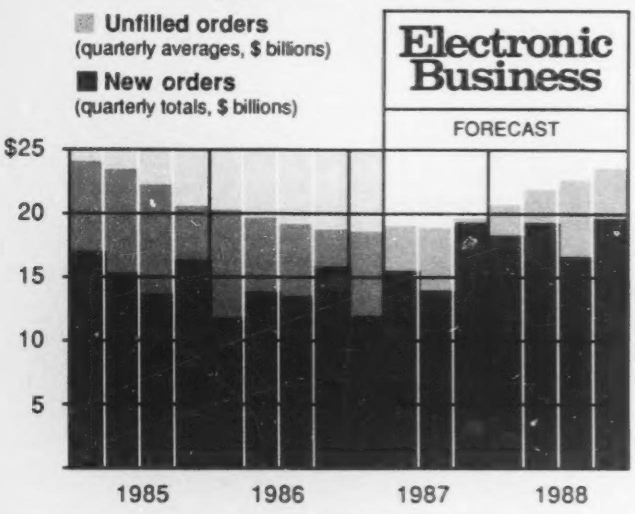
Industrial production



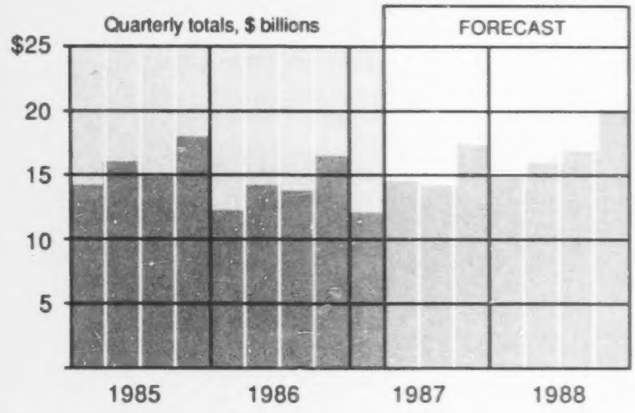
Historical data: Federal Reserve Board; Forecast: Cahners Economics

Office and computing equipment (SIC 357)

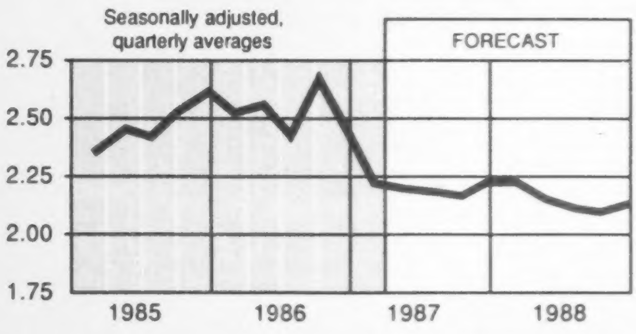
New and unfilled orders



Shipments



Inventory-to-shipment ratio



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

New orders

Rising a steady 2.6% above year-ago levels, new orders for office and computing equipment stood at $11.9 billion in the first quarter of 1987. Continued strength in orders for April and May of this year point to a strong second-quarter showing as well. Increased spending for microcomputers, minis and workstations is the impetus behind this surge. In fact, the business cycle upturn for computer orders is now in full swing. Improved corporate balance sheets will fund even more machinery investment in 1988. Coupled with gains in export markets, domestic manufacturers are expected to see an 11% rise in orders by the end of this year and a 21.6% surge in 1988.

Shipments

The rise in orders is just beginning to translate into an increase in office and computing equipment shipments. In the first quarter of 1987, shipments actually fell 2.3% below year-ago levels. But early evidence from the second quarter of 1987 shows that shipments are on the rise. Indeed, in May, manufacturers shipped about $4.42 billion worth of equipment, an increase of 10.9% over April and 6.1% over May 1986. Shipments are expected to rise even faster in the third quarter. By end of the year, shipments are likely to hit $57.8 billion, a 2.8% annual gain. In 1988, expect shipments to grow 17.0%.

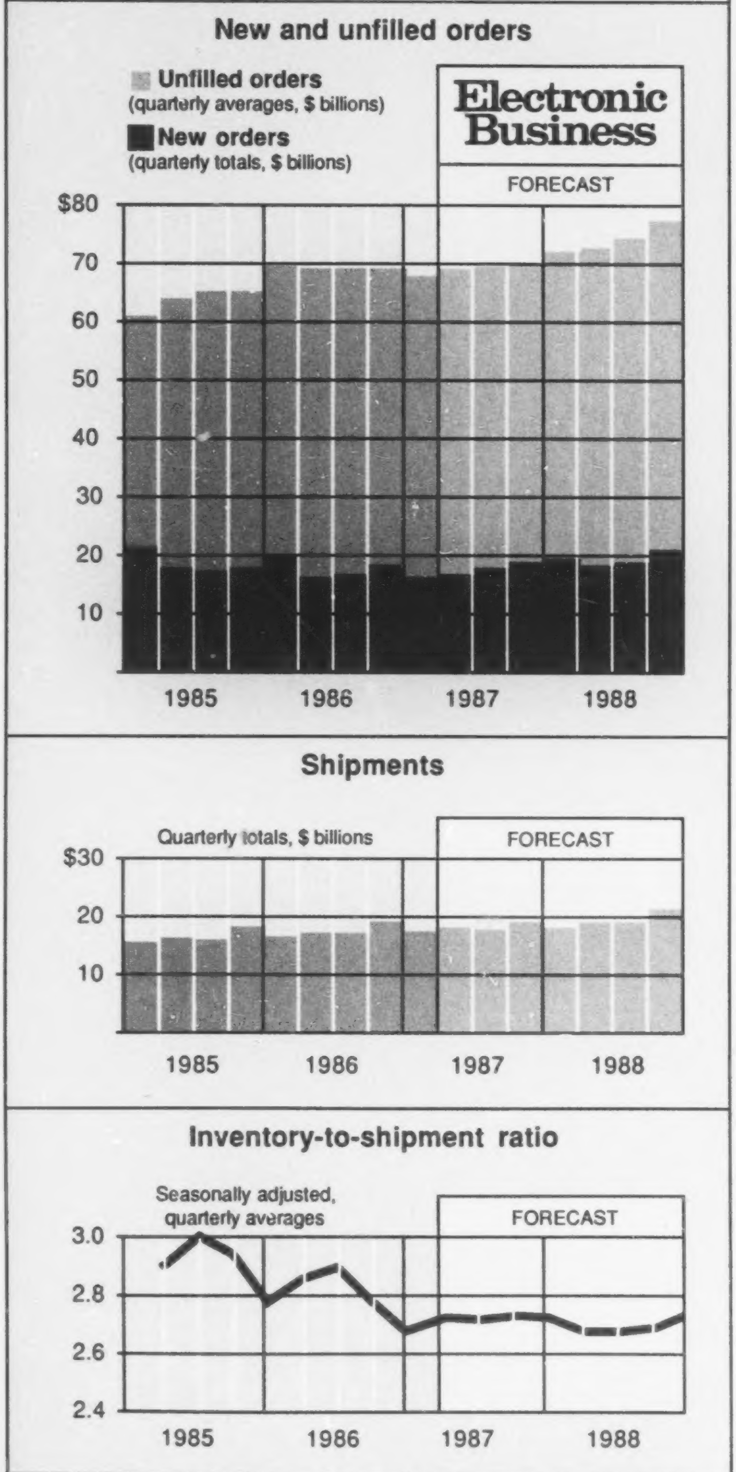
Unfilled orders

Manufacturers backlogs fell to $18.5 billion by the end of the first quarter of 1987. January's backlog of $80.1 billion, was the lowest level of unfilled orders in four and a half years and was 25.2% below the previous backlog peak of $24.2 billion set in June of 1984. A pickup in orders is expected to spark a gradual increase in backlogs by the fourth quarter of this year and into the beginning of next year. Not until the fourth quarter of 1988 are office and computing equipment backlogs expected to rise above $23 billion again.

Inventory-to-sales ratio

With the rapid depletion in backlogs, inventory of office and computer equipment fell over $2 billion in early 1987 compared with the year-ago period. From a previous high of 2.71 set in January of 1986, the inventory-to-sales ratio fell to a low of 2.02 11 months later. Since then, the inventory-to-sales ratio has fluctuated, rising to 2.17 in March and falling to 2.06 in May. Rising shipments and a tight inventory policy influenced by post-recession psychology will keep the ratio below 2.2 throughout the next year.

Communication equipment (SIC 366)



New and unfilled orders

Shipments

Inventory-to-shipment ratio

Historical data: U.S. Commerce Department; Forecast: Cahners Economics

New orders
Communication equipment manufacturers received $16.4 billion in new orders during the first quarter of 1987, a drop of 13.4% from the prior quarter and 18.9% from the year-ago period. A slackening in military procurement obscured the fact that bookings for nondefense communication equipment have improved. The current rebound in the nondefense segments, plump order backlogs, and a likely pickup in DOD spending on C^3I programs later this year make the near-term market outlook less grim than the recent bookings data suggest. Quarterly orders are expected to turn around in the second quarter of this year. But, the improvement will not be enough to prevent 1987 from posting a loss of 3.3%. However, a healthy 11.9% increase is expected in 1988.

Shipments
Manufacturers shipped an estimated $17.4 billion worth of equipment in the first quarter of 1987, down 8.9% from the previous quarter. However, on a year-to-year basis, shipments were still up 6.3%. Except for the traditionally slow summer quarter, shipments are expected to edge up for the rest of 1987 and through 1988. For the year, shipments are expected to climb 4.2% to $72.6 billion. Next year, an increase in the nondefense industries will push shipments up approximately 6.9%.

Unfilled orders
Order backlogs in the communication equipment industry averaged $68.9 billion in the first quarter of 1987, a dip of 0.7% from the average in the previous quarter. Projections are for backlogs to remain relatively flat during 1987, showing only 1% or 2% annual growth. By year-end 1988, backlogs are expected to expand 10% to $77.6 billion.

Inventory-to-shipment ratio
The ratio of manufacturers' inventories to shipments averaged 2.72 for the first quarter of 1987, up from the reading of 2.68 for the prior three-month period. Projections indicate that the ratio will hover at the first quarter proportion for the remainder of 1987 and drop slightly through most of 1988 as manufacturers continue to maintain disciplined inventory controls.

LABOR PRODUCTIVITY

Fewer jobs and higher productivity in electronics

White-collar productivity is increasing even as electronics firms trim their employment rolls

Ever since the U.S. electronics industry soured in late 1984, total employment has been steadily declining. Now, as the economic tide begins to turn and demand picks up, there are indications that employment growth will be slower than production growth. The bright side of the picture is that labor productivity is improving.

Based on research conducted by ELECTRONIC BUSINESS, employment in the top 25 electronics companies declined slightly — from a total of 1.916 million people in 1985 to 1.901 million in 1986. In fact, all but six companies on the ELECTRONIC BUSINESS list of the top 25 employers suffered some degree of employment contraction during the 1985-1986 time frame. Figures from the American Electronics Association (AEA) show the same trend: at the end of 1984, there was a peak of 2.59 million U.S. electronics industry employees — by March 1987, 120,000 had left the industry.

At the same time, average labor productivity improved for both the top 25 corporations and the industry as a whole. Between 1985 and 1986, revenue per employee for the top 25 increased 6.4%, from $87,930 to $93,589. Also, industry shipments per employee grew 1.4%, from $88,931 to $90,208.

For most of the top 25 electronics companies listed here, reductions in employment and productivity improvements are a response to both softening markets and various long-term shifts in business strategy. In general, many firms are restructuring; automating away from production-line jobs; moving offshore; and paring down middle- and upper-level management layers.

The Singer Co. was the biggest restructuring offender, in percentage terms. It shed its famous sewing machine division and other commercial lines in order to concentrate on aerospace and electronics. In total, Singer dropped 18,000 people, or 39% of its workforce, last year. Similarly, Honeywell Inc. sent 16,000 people packing as it realigned itself.

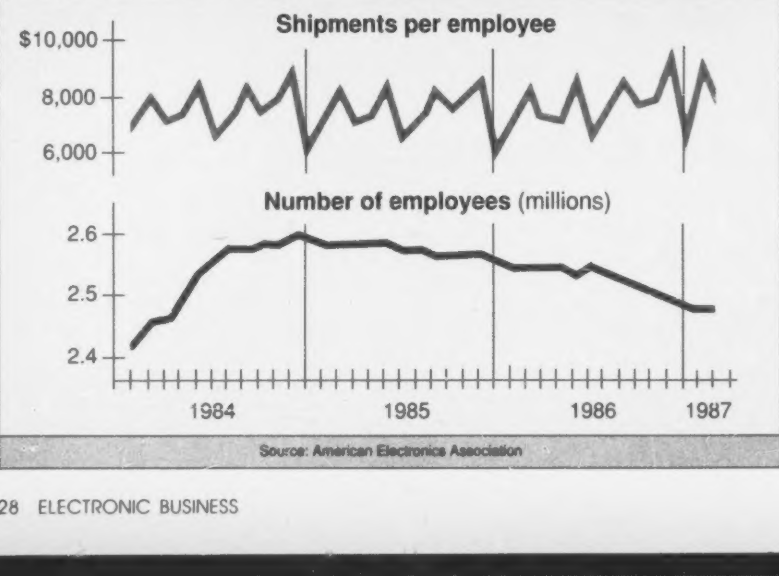
Comparatively, AT&T's job loss through restructuring almost equaled that of Singer's and Honeywell's combined. AT&T slashed 32,000 employees from its payroll in 1986 as a result of consolidation — partly as the result of its poor performance in the computer market. But chairman James Olsen is adamant about two things: R&D and capital investment. Like many of its competitors, the number two-ranked electronics giant is looking to become more capital intensive.

At the same time, the semiconductor industry has been caught in a major structural shift toward more capital-intensive production as it tries to stave off foreign competition. Intel Corp. and National Semiconductor Corp. cut their workforces by 3,100 people and 6,300 people, respectively. The exception was Motorola Inc. that increased workforce in 1986 by 4.7%.

The Bureau of Labor Statistics (BLS) of the U.S. Department of Labor, reports that the U.S. semiconductor industry eliminated 11,000 jobs between 1985 and 1986; component manufacturers cut 19,000 jobs; and the computer industry, 34,000 jobs. Even though the BLS sees employment rebounding this year, it will be at a more measured pace than the frenetic growth experienced in the late 1970s and early 1980s.

Ronald Kutscher, associate commissioner in the Office of Economic Growth and Employment Projections at the BLS, believes that 1986 was a shakeout year for the industry and that employment growth will begin to taper. By the end of the century,

Labor productivity in the U.S. electronics industry remains high, as employment declines



Source: American Electronics Association

Half of all workers in IC plants are white collar

Top 25 electronics employers

Fiscal 1986 figures

Rank	Company (EB 200 rank)	Number of employee (thousands)	Change from 1985	Revenue per employee ($ thousands)	Change from 1985	Profits per employee ($ thousands)	Change from 1985	Revenue ($ millions)	Profits ($ millions)	Fiscal year ended
1	**IBM** (1)	403.5	-0.5%	$127.0	2.9%	$11.9	-26.6%	$51,250.0	$4,789.0	12/86
2	**AT&T** (2)	316.9	-6.1%	107.6	-35.6%	0.4	-90.5%	34,087.0	139.0	12/86
3	**GM Hughes Electronics** (4)	102.0	-2.9%	102.4	13.1%	4.4	-6.3%	10,440.0	445.1	12/86
4	**Xerox** (6)	100.4	-2.0%	93.2	9.3%	4.9	30.8%	9,355.0	488.0	12/86
5	**Unisys** (7)	96.0	—	77.4	—	-0.5	—	7,432.4	-43.4	12/86
6	**DEC** (5)	94.7	6.4%	80.2	6.7%	6.5	29.9%	7,590.4	617.4	6/86
7	**Motorola** (11)	94.4	4.7%	62.4	3.4%	2.1	157.5%	5,888.0	194.0	12/86
8	**Hewlett-Packard** (8)	82.0	-2.4%	86.6	11.8%	6.3	8.1%	7,102.0	516.0	10/86
9	**Honeywell** (12)	78.1	-16.9%	68.9	-2.3%	0.2	-94.4%	5,378.2	12.9	12/86
10	**Texas Instruments** (13)	77.3	-0.8%	64.4	1.8%	0.5	NM	4,974.0	39.9	12/86
11	**NCR** (14)	62.0	0.0%	78.7	13.1%	5.4	6.8%	4,881.6	336.5	12/86
12	**N.A. Philips** (18)	50.4	-2.7%	89.9	6.0%	1.4	-13.6%	4,531.6	68.5	12/86
13	**Zenith Electronics** (34)	37.0	12.1%	51.1	3.9%	-0.3	15.8%	1,892.1	-10.0	12/86
14	**Tandy** (19)	36.0	2.9%	84.3	3.9%	5.5	1.6%	3,035.7	197.7	6/86
15	**Control Data** (21)	34.4	-11.4%	97.3	2.7%	-9.0	NM	3,346.7	-311.1	12/86
16	**Wang Laboratories** (22)	31.6	1.8%	83.5	10.4%	1.6	222.5%	2,642.5	50.9	6/86
17	**National** (39)	30.8	-17.0%	48.0	-0.4%	-4.8	NM	1,478.1	-148.3	5/86
18	**Pitney Bowes** (36)	29.2	0.6%	68.1	7.8%	5.7	14.2%	1,986.7	166.1	12/86
19	**Singer** (41)	28.0	-39.1%	62.6	19.1%	2.1	16.8%	1,752.2	58.5	12/86
20	**Harris** (29)	26.7	-15.0%	83.0	14.3%	2.2	-12.7%	2,216.6	59.6	6/86
21	**AMP** (40)	21.8	-4.4%	88.7	23.6%	7.5	59.1%	1,933.1	164.3	12/86
22	**Intel** (48)	18.2	-14.6%	69.5	8.5%	-10.1	NM	1,265.0	-183.3	12/86
23	**Tektronix** (44)	17.4	-15.5%	78.2	11.6%	2.3	-48.4%	1,357.2	39.3	5/86
24	**General Instrument** (57)	16.3	-20.5%	48.3	24.8%	1.1	NM	787.9	18.5	2/87
25	**Data General** (46)	15.6	-5.9%	81.5	8.7%	-1.9	NM	1,268.0	-29.0	9/86

NM = Not meaningful

Source: ELECTRONIC BUSINESS

Marty Braun

Kutscher predicts that the computer, semiconductor and component workforce will grow more modestly, employing 1.14 million people by 2000, up from about 1 million people for those segments in 1986.

Kutscher says that part of the reason for the high-tech job slowdown is that the makeup of the U.S. electronics laborforce is changing. The low-skilled subassembly work will continue to flow offshore, while the U.S. electronics industry will focus on high-skill design and prototype work.

There is also a shift in electronics from direct production to indirect — often white-collar — labor. For example, the U.S. Department of Commerce reports that between 1974 and 1984 the percentage of production workers in the semiconductor segment plunged to 49% of the total semiconductor workforce, from 61%. In computers, the comparable figure dropped from 49% to 41.5% and in electrical instruments, from 60% to 53.4%.

Ken McGill, an senior economist with Wharton Econometrics in Bala Cynwyd, Pa., is forecasting the labor productivity growth rates in the semiconductor and component industries to pick up in the next 10 years as both segments become more capital intensive and the makeup of the workforce changes. But McGill argues that because of the increasing foreign labor content in many U.S. products, domestic labor productivity is being overestimated. Measurements need to be changed for U.S. labor productivity because they do not account for the growing amount of foreign labor in U.S.-made goods, he says.

Capital ideas

The shift toward indirect labor indicates that direct labor is becoming virtually insignificant as a percentage of a typical product's total cost. Some companies, in fact, claim it may be as low as 2%. As a result, the focus of attention may be turning to indirect labor productivity — improving management and capital productivity, for example.

This may be a good thing. Since the beginning of the decade, U.S. capital investment has been stagnant. Overcapacity, overinvestment and slack demand has kept companies from buying new plant and equipment, and shelling out for research and development. As a result, capital productivity has suffered.

According to the American Productivity Center (APC), a Houston-based research and consulting firm, capital productivity in U.S. private businesses hit rock bottom in mid-1982 and has only slightly improved since. As demand improves, APC says, so will capital productivity. But capacity utilization is still hovering around 70% and is not under any serious pressure to increase. As a result, capital investment remains weak.

Robert Eggert, economist and president of Eggert Enterprises in Sedona, Ariz., and editor of *Blue Chip Economic Indicators*, a newsletter that reports forecasts of top U.S. economists, says that over the last six months he has seen a turnaround in capital spending. This has been stimulated mainly by the drop in the value of the dollar which is, in turn, stimulating overseas demand for U.S. products.

THE BIGGEST GAINS in productivity can be achieved by making white collar workers more efficient

Marty Braun

Priscilla Luce Trumbull, senior economist and director of industrial services at Wharton Econometrics is not as sanguine. She believes that there will be a slight uptick in capital investment later this year. During 1986, capital investment was very bumpy largely because of the Tax Reform Act of 1986. "We haven't seen a significant improvement yet, but we are expecting it to pick up soon," she says.

Despite the sluggishness of capital investment, Trumbull believes that much of the investment that has been made over the last two years was geared toward enhancing labor productivity rather than expanding facilities and building new plants. Factory-floor computer systems, automated testing equipment and materials-handling equipment all contribute to improved labor efficiency and productivity. If traditional capital investment stays low, as it is expected to do, then this productivity kind of capital investment will no doubt continue and become more significant.

Just-in-time manufacturing — getting components to the factory floor just in time for production — is one low-capital technique that is contributing to improvements in labor productivity. Mostly JIT involves long-term investment in changing management attitudes and strategies, rethinking production techniques, and focusing on quality control.

International comparisons

But, even though domestic labor productivity is improving, foreign labor productivity often improves at a faster rate. The BLS, estimated that in 1985, U.S. manufacturing labor productivity increased by 4.4%, while Japan's rose by 5% and West Germany's by 5.6%. Japan is at the top of the list in manufacturing labor productivity growth between 1982 and 1985 while the U.S. ranked eighth. And, in electrical machinery, the American Productivity Center says that Japan's productivity growth was five times greater than America's between 1980 and 1983.

In 1986, Japan's top 20 electronics firms reported labor productivity of $267,100 sales per employee, but the top 20 U.S. firms reported only $88,700 [ELECTRONIC BUSINESS, April 1, p77]. Although the weakening dollar is providing some respite from offshore competitive pressure, the U.S. government's huge capital requirements caused by the federal budget deficit may ensure that the dollar will not fall further.

As foreign demand for U.S. goods increases, the renewed energy that foreign countries will place on productivity improvements in their export industries will offer future challenges to U.S. manufacturers. This is hardly a cause for celebration in domestic industry, particularly electronics. The best that can be expected, most experts say, is a continued steady upward trend.

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SOUTHEAST ASIA

Diversification is the word in Kuala Lumpur

Burned by the chip slump, Malaysia now wants to go beyond IC assembly and move into other areas of electronics

Malaysia, the chip-assembly capital of Southeast Asia, is looking for ways to diversify its electronics industry.

Jobs have a lot to do with it. American-owned electronics subsidiaries employed 35,900 Malaysians last year, slightly more than they did in 1985, but still down about 8,000 jobs from their peak year in 1984. Admits N. Sadasivan, director general for the local Industrial Development Authority: "Our value-added is minimal, less than 2% to 3% of the total output. If we achieve improvements in that, we will be more than satisfied."

Sadasivan is betting that the 2-year-old Malaysian Institute of Microelectronic Systems, or MIMOS, will help to pump up the industry. MIMOS is an R&D lab for the use of companies operating in Malaysia.

The government's strategy is to get foreign companies to make more finished products in Malayaia. Also, Sadasivan wants to build on the chip assembly foundation by attracting more front-end chip manufacturing. Already National Semiconductor Sdn. Bhd. is doing so. To encourage all of the above, the government founded MIMOS in Kuala Lumpur.

Staffed by 40 engineers and with an annual budget of a couple of million dollars, MIMOS offers six courses a year in electronic design. MIMOS director general Tenku Mohd Azzman Shariffadeen, originally an academic, got tired of seeing his students get jobs as equipment operators in foreign-owned assembly plants.

In addition to government funding, MIMOS has received money from LM Ericsson Telephone Co., GEC Plc and NEC Corp. GEC will be the first to show commercial fruits from its venture, Shariffadeen says, with a MIMOS-designed telecom chip for its Marconi Italiana SpA subsidiary. The British Marconi got a big order last year from the Malaysian Telecommunications Authority for pulse code modulators and telephone multiplexers, which might have encouraged the MIMOS relationship. Likewise, Shariffadeen says NEC just wanted to be a "good corporate citizen" with its half million dollar donation, but he hints that products are in the works, as well.

MIMOS also has a charter to de-

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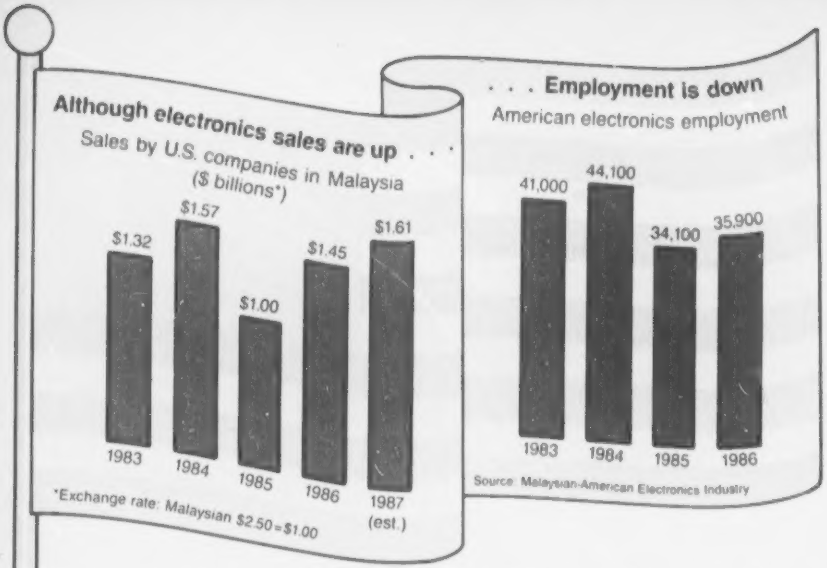

Source: Malaysian-American Electronics Industry

velop its own products. Among the first will be a single-board, under-$1,500 computer to be marketed by a local company.

Although MIMOS had to first turn to Sweden for its electronic design software — the United States was embargoing Malaysia at the time —it now uses systems from Mentor Graphics Corp., purchased through Malaysian universities. The design software runs on four Apollo Computer Inc. workstations, one of which was donated by GEC. MIMOS also has a handful of Sun Microsystems Inc. workstations donated by Australia, and a supermini purchased from Digital Equipment Corp.

The dozen U.S. electronics companies in Malaysia made up over half of the country's $2.6 billion industry in 1986, and should have sales of $1.6 billion this year, according to the Malaysian-American Electronics Industry, the local trade organization. So far, none of those companies has availed itself of MIMOS' services.

Most of them agree with MAEI chairman Roger Bertelson, managing director of Motorola Semiconductor Sdn. Bhd., who says that "circuit design is still going to come from being close to the customer base" — namely, back in the United States. "Chip design, that's out of my line," adds Russell Smith, managing director of RCA Sdn. Bhd. He says that his personnel in Malaysia are in manufacturing.

One company that has used MIMOS, however, is Accent Technology Sdn. Bhd., a Malaysian-owned maker of IBM personal computer clones. Chief executive Larry Risser says that he should be cranking out PCs at the rate of 800 a month by the year's end. He is producing 300 a month now, partly for government contracts to the state-run airline and the national electric power agency.

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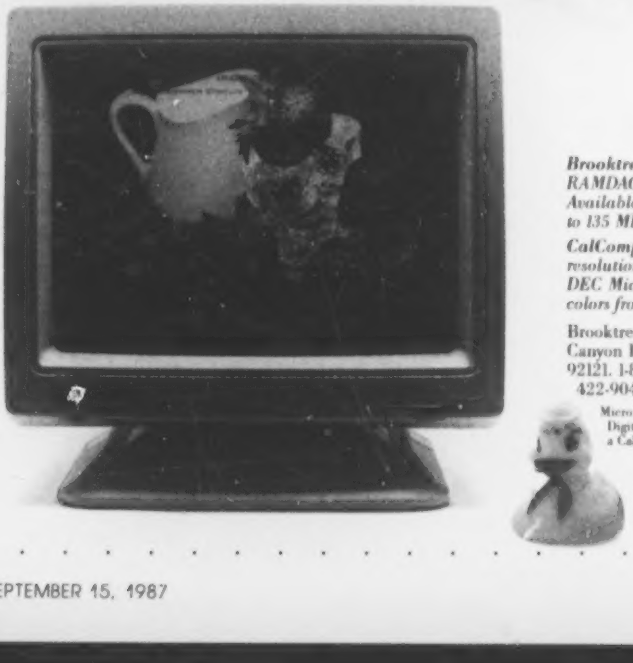
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MULTINATIONALS

NEC takes the Triple Crown in electronics

Call it the "three Cs." Under Tadahiro Sekimoto, NEC is 1st in chips, 5th in computers and 5th in communications

By Alden M. Hayashi

Call it the Triple Crown in electronics. Or call it the grand slam of the industry. But whatever you call it, NEC Corp. of Tokyo is the only company to achieve it.

With sales of $16.8 billion last year, NEC alone ranks among the top 10, worldwide, in the three most important markets of the electronics industry: chips, computers and communications. The company is No. 1 in semiconductors, fifth in data processing and fifth in telecommunications equipment. No other company, not even IBM, can make that claim.

"IBM's computer sales are maybe 10 times more than NEC's. And AT&T's communications sales are about three times more than ours- . . . . But we are the only company ranking in the top 10 in all three areas," boasts Tadahiro Sekimoto, NEC president for the past seven years.

An animated speaker, Sekimoto often sketches charts and graphs to illustrate his points, a trapping of his Ph.D. training in engineering. But he is not just a numbers man. Prone to lengthy philosophical discussions, he enjoys chatting about how NEC's marriage of the computer and communications technologies, or "C&C" as the company's slogan has it, will help better society and improve world peace. And help NEC retain its Triple Crown.

The ultimate goal of NEC, says Sekimoto, is the creation of "artificial servants" to serve man. Such advanced robots, he says, will have computers for brains, software for intelligence, communications technology for nervous systems, peripherals (such as disk drives) for their five senses, and semiconductors for tissue. Because of NEC's mastery of chip, computer and communications technology, the company is uniquely positioned to develop such artificial servants for the 21st century, claims Sekimoto.

He and chairman Koji Kobayashi are NEC's technology visionaries. Both foresee the day sometime early next century when NEC will perfectly unite computers and communications by developing a computerized telephone translator product. A user of such a system will be able to talk into a phone in one language and be heard in another.

In addition to foresight, Sekimoto lists NEC's three other management precepts: execution, perseverance and flexibility. Indeed, it is NEC's flexibility that is helping the company

NEC ranks among the top 10 worldwide in...

Semiconductors

1986 production ($ millions)

1	**NEC**	$2,560
2	**Toshiba**	2,270
3	**Hitachi**	2,160
4	**Motorola**	1,960
5	**Texas Instruments**	1,850
6	**Philips***	1,325
7	**Fujitsu**	1,145
8	**Matsushita**	1,145
9	**Mitsubishi**	990
10	**National**	970

* Includes Signetics

Source: Integrated Circuit Engineering Corp.

Computers

1986 sales* ($ billions)

1	**IBM**	$47.6
2	**Unisys**	9.4
3	**DEC**	8.4
4	**Fujitsu**	6.0
5	**NEC**	5.6
6	**Hitachi**	4.6
7	**NCR**	4.2
8	**Hewlett-Packard**	4.2
9	**Olivetti**	3.7
10	**CDC**	3.3

* Includes hardware, software, peripherals, service and maintenance

Source: *Datamation magazine*

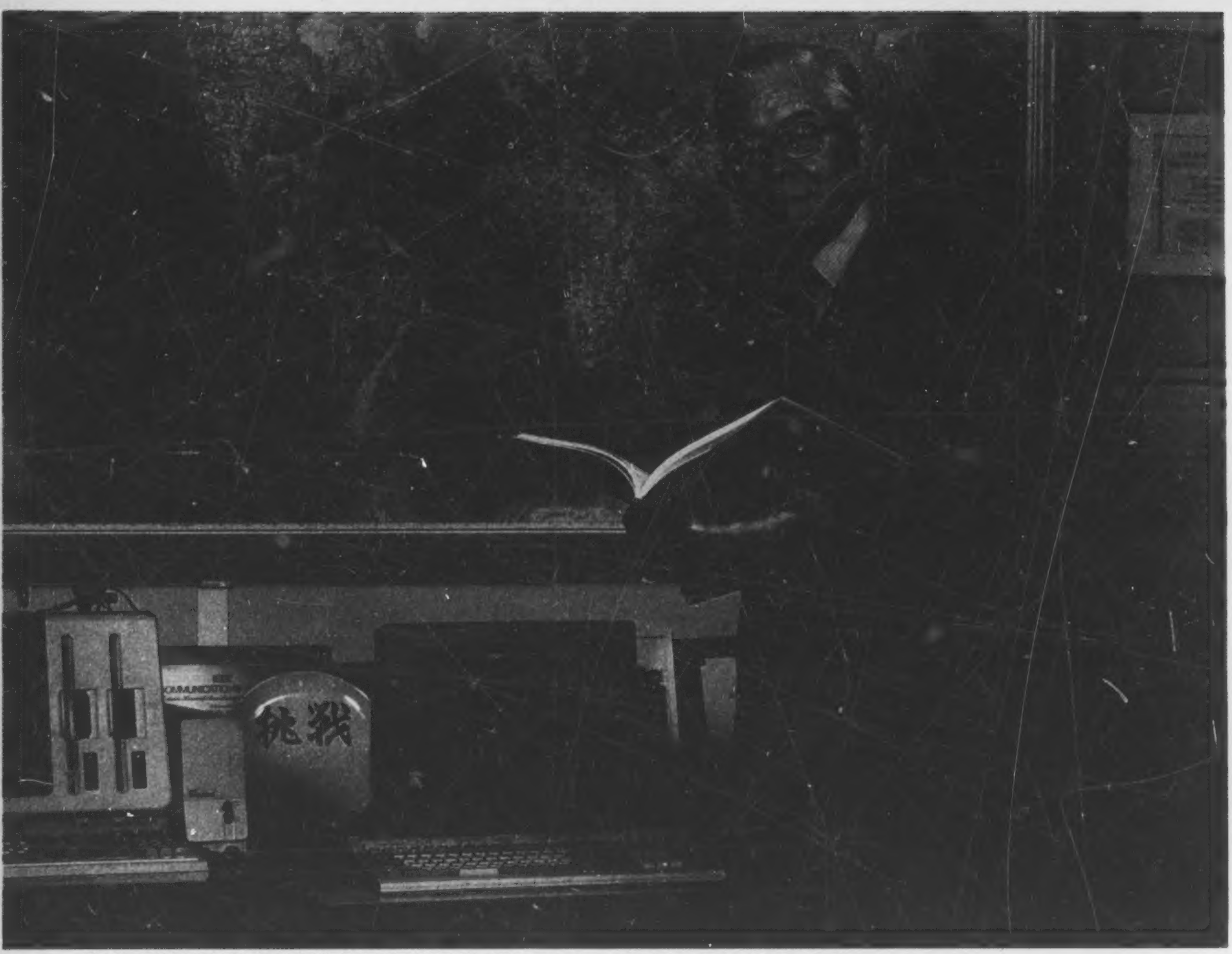
Telecommunications

1986 sales ($ billions)

1	**AT&T**	$10.2
2	**Alcatel N.V.**	8.0
3	**Siemens***	5.6
4	**Northern Telecom**	4.4
5	**NEC**	4.0
6	**Ericsson**	3.1
7	**Motorola**	2.8
8	**IBM**	2.7
9	**Philips**	2.0
10	**GEC**	1.9

* Includes Siemens' share of its joint venture with GTE

Source: Arthur D. Little Inc.



NEC's PHILOSOPHER PRESIDENT SEKIMOTO: "Our company must keep running forever"

weather the current yen crisis which has battered every export-oriented Japanese conglomerate. For over two years now, the yen's value has soared more than 70% upward against the dollar, making Japanese exports into the United States that much more expensive.

Instead of raising its U.S. prices accordingly, NEC is taking the bulk of the yen value's increase square on the chin. Consequently, the company suffered a huge 60% plunge in its total net income in 1985 and a subsequent 45% fall last year. In fact, the company barely eked a profit of $103 million on sales of $16.8 billion in fiscal 1986, ending last March. "NEC's earnings have been under extreme pressure recently," says George Haloulakos, analyst with Dain, Bosworth Inc., headquartered in Minneapolis. Adds C. Robin N. Norton, analyst with S.G. Warburg & Company Inc. of New York City: "NEC's technology is still very good but the profitability of that technology has fallen."

Rajiv Chaudhri of Goldman Sachs & Co. of New York City estimates that roughly 10% of NEC's total sales are made in North America. He questions whether NEC is profitable today in the United States. "In telecommunications," Chaudhri asserts, "NEC is definitely not profitable. They're getting killed here. In semiconductors, they may be breaking even . . . . On the whole, it's fair to say they're not making any money in the U.S. because the amount of money they are losing in telecommunications would not be made up by any profit that they might be making elsewhere." NEC executives deny that their U.S. operations are losing money. Still, Sho Nakanuma, associate senior vice president, admits: "¥140 to the dollar is very tough for us."

It is NEC's flexibility that is helping the company weather the current yen crisis

It could get tougher. In Tokyo last month, rumors circulated that NEC was being investigated for allegedly selling contraband high-tech products to the Soviet bloc. The company and the U.S. government have denied the rumors. But the consequences could be catastrophic since Congress is already forcefully pressing Toshiba for exporting high-tech goods to Russia.

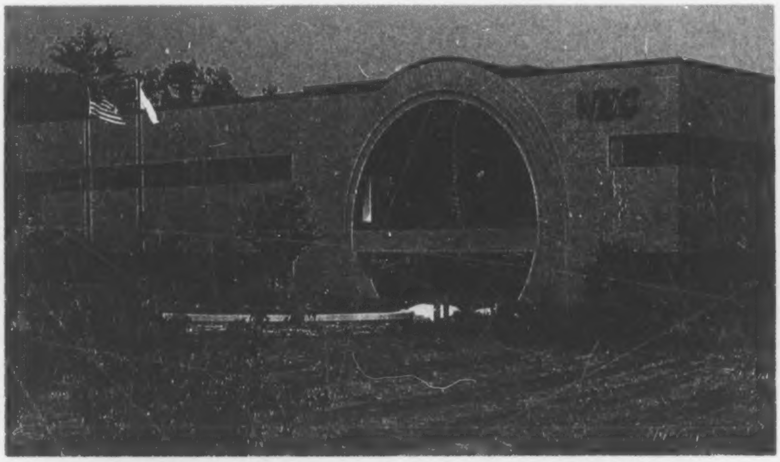
Grounding the soaring yen

Rumors regarding Russia notwithstanding, president Sekimoto has been busy implementing various strategies to offset the high-flying yen:

- *Cut production costs by applying draconian measures to increase productivity. In addition, buy more parts and raw materials offshore where the yen's higher purchasing power is an advantage.* So far, NEC has made great strides here. At one of its computer factories in Ibaraki, Japan, the company was able to double its productivity within a year's time (See accompanying article.) And be sure that NEC is desperately looking to buy parts, particularly electronic components, from the newly industrialized countries (NICs). The problem, however, says NEC's top management, is that good quality parts cannot often be found outside of Japan.

- *Escape the clutches of the high-valued yen by doing more manufacturing outside of Japan.* Already one-third of NEC's foreign sales are produced overseas, according to Sekimoto. The company is planning to increase that ratio to one-half by 1990. In the United States, the company is quickly expanding chip production in Roseville, Calif.; computer and peripherals assembly in Boxborough, Mass., (see accompanying article); and PBX manufacturing in Dallas. In addition, Nakanuma says: "We are considering opening another semiconductor factory in the U.S." Last April, NEC commenced operations in a new chip plant in Livingston, Scotland. The company is especially interested in moving its manufacturing of commodity products to foreign countries. According to Toshiro Kunihiro, executive vice president, NEC will double its offshore production of key telephones and low-end private branch exchanges within the coming year.
- *Avoid competition from companies in Southeast Asia (where currencies have also fallen against the yen) by deemphasizing commodity products and concentrating on higher value-added ones that can command premium prices.* NEC already is much less dependent on commodity products than other Japanese conglomerates. Consumer products make up just 13% of NEC's total revenue whereas at Matsushita Electric Industrial Company Ltd. that percentage is 62%. NEC has begun to contract out its production of low-end consumer products to various Southeast Asian companies: some of NEC's microwave ovens, small-capacity refrigerators and small-screen televisions will reportedly now be made by South Korea's Daewoo Corp. and Goldstar Co. In addition, Sekimoto says that software will help NEC move further upmarket. "That is our goal today: products armored with software," says Sekimoto. He is also counting on software to help automate and

NEC here and abroad: A tale of two factories



NEC's BOXBOROUGH FACTORY in Massachusetts will begin assembling disk drives this fall and printers early next year. Business is booming

For more than two years now, the value of the yen has been soaring against the dollar. Where ¥1000 was worth only $4.00 before, it is worth $6.85 today. This 71% shift in the yen's value has overjoyed the camera-toting Japanese tourist but not his employer. Exporting manufacturers in Japan now find that, at the same yen prices, their products in the United States are 71% more expensive in dollar terms. This new currency reality has forced Japanese executives to revamp their manufacturing strategies.

The best of times

NEC's computer plant in Boxborough, Mass., is now bustling, due in part to the yen's appreciation. The total number of workers involved in manufacturing at NEC Information Systems Inc. (NEC IS), which runs the Boxborough facility, has increased from around 200 employees to more than 300 employees over the past year, according to Herbert A. Spivak, NEC IS vice president for manufacturing. Spivak contends that, at an exchange rate of ¥140 = $1, manufacturing labor costs between the United States and Japan are roughly equal, all things considered, including employee benefits.

The Boxborough plant — supplier of computer hardware to Honeywell, NCR, Prime, Tandem and Wang — commenced manufacturing nearly two years ago with the monthly assembly of 10,000 printer form feeders. Although all of the parts for the feeders were originally imported from Japan, NEC IS currently buys the plastic ones locally because they are 15% cheaper in the United States due to the yen appreciation, according to Spivak. He is looking locally also to procure the metal parts for the feeders because, at the current yen/dollar exchange rate, those parts cost the same in the states as they do in Japan, he says.

More recently, the plant began assembling and testing NEC's personal computers. According to Spivak, NEC IS made the decision to assemble PCs in Boxborough in order to avoid the 100% tariffs that the Reagan Administration imposed on imported Japanese PCs last April. Furthermore, Spivak adds, "with the yen the way it is, there is no advantage to importing PCs from Japan."

The Boxborough plant currently imports the major PC parts such as the disk drives, power supplies and motherboards from Japan. Only the Intel Corp. microprocessor and some chips from Chips and Technologies Inc. of Milpitas, Calif., are procured locally, according to Spivak. However, he says NEC IS is currently taking local price quotes for the PC metal housing and chassis parts. The Boxborough plant's next make NEC's manufacturing operations more versatile. "Before," says Sekimoto, "mass manufacturing was considered to be the source of profit. Today, we have to change our manufacturing mindset from mass production to the production of a greater variety of products in smaller lots."

- *Protect NEC from any further increase in the yen's value by locking in contracts with banks to exchange the dollar at a guaranteed rate.*

Thanks to Sekimoto's quick actions, particularly in increasing offshore manufacturing, NEC is well on its way to recovery. The company is predicting that its total net income will rebound to $171 million this year, a 66% increase over last years' results. Furthermore, NEC estimates that sales this year will increase 10% to $18.5 billion.

But, even though NEC has been experiencing extreme profit pressures because of the strong yen, the company has not been R&D stingy. NEC has maintained a research and development spending level of around 12% of total sales. Two years ago, the company spent 14%. In contrast, IBM spent 8% last year while AT&T spent 7%. "NEC operates on pretty thin profit margins. They plow a lot into R&D and capital investments," says Norton of S.G. Warburg. NEC's shareholders have seemed content to let the company operate on meager margins. It does not hurt that the giant Sumitomo Bank of Tokyo holds 5% of NEC's stock.

NEC has maintained an R&D spending level of around 12% of total sales

According to Sekimoto, NEC will maintain an R&D spending level of at least 10% of total revenue, come rain or shine. "U.S. companies try to save R&D money immediately when their profitability decreases. But not NEC. There is only one way NEC can survive: by spending money on R&D," says Sekimoto. Adds Yoshiteru Ishii, senior executive vice president: "NEC does not skimp." Indeed, the company uses an aggressive three-year depreciation plan which allows for up to 50% depreciation in the first

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step is to buy the PC power supplies from local vendors.

"Our long-term corporate objective is to, as much as possible, design products in the U.S. and build them here for the U.S. market," says Spivak. He lists several reasons why NEC IS wants to increase its U.S. manufacturing: to be closer to the local market, to avoid any tariffs, for political goodwill, and, he adds, "because of the strong yen, it's become economically sensible as well." Indeed, NEC IS is planning to begin assembling disk drives this fall and printers early next year.

NEC's IBARAKI FACTORY has been ordered to cut costs drastically. According to the facility's manager, productivity should double within the next two years

The worst of times

While the strong yen has been a blessing for NEC's Boxborough facility, it has been a curse to the company's plant in Ibaraki, Japan, where NEC manufactures mainframe computers and Winchester disk drives. Fully 40% of the Ibaraki plant's output is sold outside of Japan and is consequently subject to considerable price inflation. Not surprisingly, the factory was ordered to slash production costs immediately. Or else.

The Ibaraki plant was up to the task. According to Junzo Yamamoto, NEC Ibaraki Ltd. president, the manufacturing facility was able to double its productivity within one year. Yamamoto credits employee involvement with the achievement. Through an employee suggestion box, 24,000 propductivity enhancing recommendations were received last year from 600 workers directly involved in the manufacturing process. Of the 24,000 suggestions, more than 1,000 were implemented which helped achieve the 100% increase in productivity, according to Yamamoto.

Inside the Ibaraki plant is a bulletin board that tracks which employees have submitted the highest number of suggestions. For the first three months this year, the leading employee had already proposed 410 suggestions. Yamamoto's valiant goal is to double again his factory's productivity within the next two years. He is striving for twice as many employee suggestions this year.

Yamamoto adds that besides employee suggestions, automation has also helped to increase his factory's productivity. According to him, the Ibaraki facility is now 70% automated, up from around 50% a few years ago. This is in sharp contrast to NEC's Boxborough plant where virtually all of the labor is done by hand.

In addition to cost slashing, Yamamoto has also been busy trying to procure cheaper parts and raw materials from Southeast Asia, where the yen's strong purchasing power is an advantage. However, he says, "good disk-drive components are difficult to find outside of Japan." Foreign suppliers might do well to visit Ibaraki. According to Yamamoto, only one foreign salesman, from U.S. capacitor manufacturer AVX Corp., has called on him during his four years at Ibaraki. The AVX salesman got the order. ☐

year, according to Chaudhri of Goldman Sachs. Such a plan, says Chaudhri, allows NEC to stay at the leading edge of manufacturing technology by replacing old equipment quickly.

In his discourse of NEC's management precepts of foresight, execution, perseverance and flexibility, Sekimoto forgot to mention one more item: courage. With Japanese-style chutzpah, NEC has made many a gutsy decision. Instead of developing IBM-compatible mainframe computers as did compatriots Fujitsu Ltd. and Hitachi Ltd., NEC instead chose IBM independence. And NEC is the first major Japanese company to market a proprietary microprocessor architecture. □

Chip challenges, a Roseville by any other name

NEC's strategy to push its homemade microprocessor is bold to say the least. The industry has for years been ruled by U.S. architectures from companies such as Intel Corp., Motorola Inc., National Semiconductor Corp. and Zilog Inc. The Japanese companies historically have been content to second source the U.S. designs.

And the Japanese companies have done well by such arrangements. NEC, a second source of the Intel architecture, was No. 2 worldwide in the metal-oxide semiconductor (MOS) microprocessor and corresponding peripheral chip market with sales of $525 million last year, according to Integrated Circuit Engineering Corp. (ICE), a market research firm in Scottsdale, Ariz. And Hitachi, a Motorola second source, was No. 4 with sales of $160 million, according to ICE. But, clearly, NEC has tired of its dependence on Intel. Sho Nakanuma, a NEC vice president and former head of the company's U.S. chip operations, says that he hopes to establish one more standard in the marketplace, that of NEC's V-series architecture.

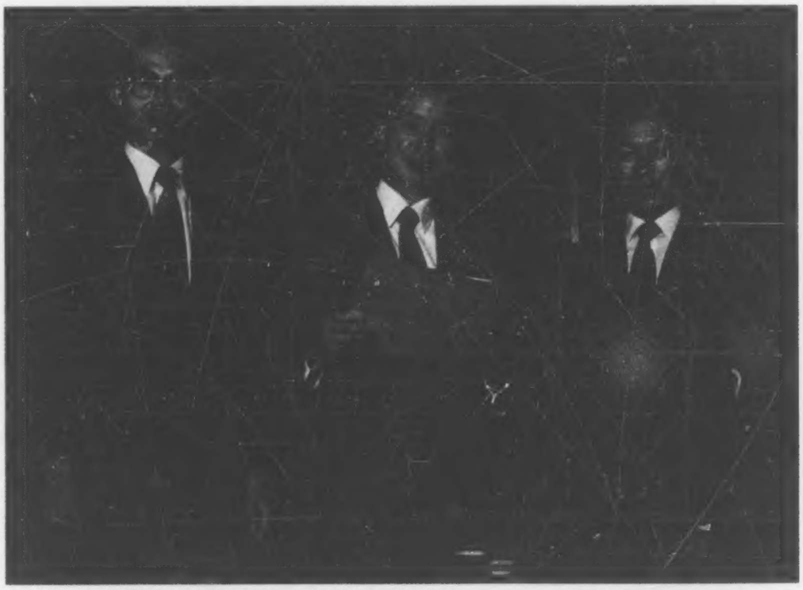
But Nakanuma's plan has hit a snag. Intel is suing NEC, claiming that NEC's V20 and V30 microprocessors are not originals but disguised copies of Intel's products. So far the U.S. courts have ruled that Intel's microcode, the software instruction set embedded in the microprocessor hardware, is copyrightable. But the courts have yet to decide whether or not NEC infringed on that copyright.

The case has been dragging on for more than a year now, which apparently suits NEC just fine. Nakanuma says that the life span of the V20 and V30 is getting shorter day by day. Meanwhile, NEC announced last April its newest microprocessor, the 32-bit V70 which supports the Unix operating system. Nakanuma asserts that there will be no copyright problems with the V70. "The V70 is 'cleanroom' microcode. We developed it without any knowledge of the Intel microcode," he says.

Regardless, legal problems may be the least of NEC's concerns. Convincing customers to switch from Intel, Motorola or National will be difficult, admits Nakanuma. Accordingly, NEC's plan is to first pursue niches in the marketplace. With sample shipments that commenced last July, NEC is targeting applications in computer-aided design/manufacturing, private branch exchanges, robotics and other industrial equipment. Although the outcome of NEC's push to create another standard in the industry is highly uncertain, Nakanuma is determined: "The V70 is an investment in the future." NEC itself will be using the V70 in a new 32-bit PC.

V70 shipments will take awhile to ramp up, but business at the company's Roseville, Calif., plant is booming. In a curious turn of events, last year's U.S.-Japan semiconductor trade pact is actually aiding NEC's U.S. chip efforts. Because the pact implements price floors on Japanese imported chips and because other Japanese companies do not have the U.S. manufacturing capability that NEC does, the trade agreement is favoring NEC over its Japanese peers. Furthermore, the pact covers certain DRAMs, a type of memory chip that most U.S. manufacturers gave up making years ago.

Consequently, NEC's Roseville plant is racing along at top speed. With full wafer-fabrication capability, the facility is churning out 70% more chips this year than last year, according to Nakanuma. Currently, 3 million to 3.5 million 256-kilobit DRAMs are being produced there monthly. NEC expects that figure to rise to 4 million soon. Not surprisingly, NEC plans to expand its $100 million Roseville plant. By the early 1990s, the company will have invested an additional $600 million in Roseville and the facility will then be employing 3,000 people, up from 650



NEC's KUNIHIRO (left), **ISHII** and **NAKANUMA** (right): Communications, computer and chip guardians of the company's Triple Crown in electronics

DISTRIBUTION

Tape drive? Computer? Coming right up, sir

Alongside chips, distributors now offer computer products galore. One day they might even make money at it

By John Kerr

When Digital Equipment Corp. handed all its smaller end user and reseller accounts to industrial distributors this spring, it may as well have hoisted a banner declaring: "Distribution gets our vote!"

It is a vote cast more often by computer product vendors these days as their distributors grasp the nuances of selling everything from tape drives to completely configured minicomputer systems.

Increasingly too, distributors are marketing vendors' wares not only to original equipment manufacturers but to value-added resellers and even to end users.

But the business of selling computer systems and subsystems cannot yet be termed an unqualified success for distributors. "There have never been any problems with growing; the problem's been making money," says Robert Throop, chief executive of San Jose-based Anthem Electronics Inc., one of the few distributors to consistently make handsome profits.

It is true: profitability in systems sales hardly afflicts the middlemen en masse: "There are many who consider systems break-even at best," says Stephen Kaufman, president of Arrow Electronics Inc. of Melville, N.Y., the third-ranking U.S. industrial which Kaufman admits makes little or no money on computer products.

However, distributors may be making progress in coping with customers. Says William Roach, worldwide director of distributor marketing and sales at Santa Clara, California-based Intel Corp., which uses distributors to sell many of its single-board computers and microprocessor development systems: "In the last three years, industrial distribution has evolved into an effective channel. Probably the biggest single factor is that they are becoming much more competent technically."

Observers maintain that computer products gave the distribution business its only growth during the semiconductor downturn

Adds Peter Snell, director of reseller marketing for San Jose terminals maker Wyse Technology: "It's been our experience that [distributors] have been very strong partners for Wyse."

Customers notice the difference. "They've become quite a lot more responsive in the past two years," says Lynde Wylie, administrative assistant at Aurotech Inc., a small Denver VAR that buys monitors and printers from distributors for use in food management systems. Another praises Cypress, California-based Ducommun Data Systems (DDS), a division of Ducommun Inc., for burning in the AT&T 3B minicomputers that it buys, and for loading the Unix operating software, a job that takes hours.

Computer products, in turn, get the thumbs-up from hungry distributors. Several observers maintain that disk drives, printers, desktop computers and the like gave the distribution business its only growth during the dog days of the semiconductor downturn — indeed, that 70% of the industry's growth in volume since 1980 has come from systems.

Others cite vast market potential: in its 1987 annual report, Cleveland-based distributor Pioneer-Standard Electronics Inc. claims that although about 30% of component sales move through distributors, under 2% of management information systems sales now use that channel. "I would describe computer systems' potential as explosive — I don't think that's overstated," adds Ralph Ozorkiewicz, president of Wyle Laboratories' Electronics Marketing Group in Irvine, Calif.

Distributors' computer products sales have clearly been climbing steadily. Wyle's Ozorkiewicz sees his systems sales expanding 30% a year at least over the next three years — three times the average growth the industry can expect. At big league companies like Anthem, Arrow, Pioneer and Wyle, a third of their revenue

WILLIAM ROACH, worldwide director of distributor marketing and sales at Intel: "In the last three years, industrial distribution has evolved into an effective channel"

now comes from computer products. At the electronics group of Ducommun — one of the largest distributors of computer equipment — the figure is 40%.

Financial analysts who follow the distribution business agree that computer systems will be distributors' fastest growth prospect by far. At San Francisco brokerage Montgomery Securities, analyst Andrew Neff sees systems generating $2.45 billion of electronics distribution's total $7.9 billion in sales in 1988, up from $1.8 billion of last year's aggregate of $6.3 billion.

Vendors are looking for similar leaps: Intel's Roach expects his distributor sales to double next year from this year's $100 million-plus. DEC's plan calls for more than quadrupling annual revenue through distributors to over $1 billion by 1990, with half of that expected from industry leader Hamilton/Avnet alone.

Acceleration of distributors' computer product sales is no accident. The personal computer phenomenon gave it a jolt as small peripherals fast became commodities and as more and more vendors viewed distribution as the natural extension of their salesforces — the channel that would reach the second- and third-tier customers.

Another factor: those smaller customers — many of them VARs — constitute a rapidly expanding new market that is well worth cultivating: some will turn out to be the Intels and DECs of tomorrow.

Additionally, the products, such as disk drives and terminals, have become more standardized while distributors have become more familiar with them and more technically able to handle them. The trend continues: integration of controller boards onto disk drives, for example, makes the sell simpler. Meanwhile, customers are showing a growing tendency to buy systems and subsystems, rather than making their own from components.

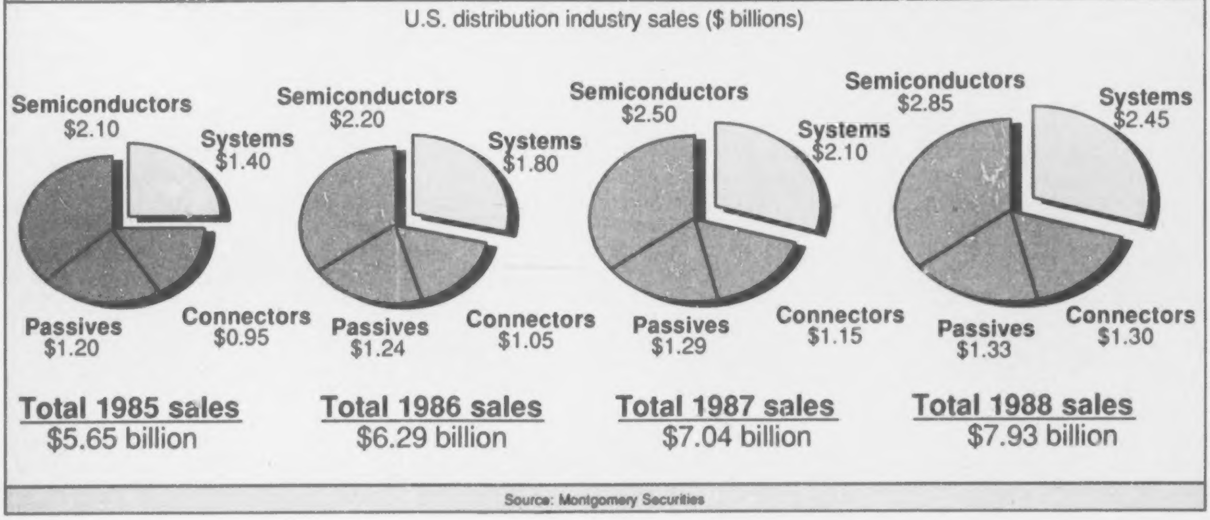
Channeling

Distribution's computer products sales are an outgrowth of franchises for microprocessors; many potential users began buying board- and box-level processors rather than buying and assembling the individual chips; others chose boards or boxes as platforms to experiment with microprocessors before committing to purchase.

The sector easily predates the PC; at about the time the earliest Apples were appearing, about 4% of distribution's sales already came from systems. Intel was using the channel from the early 1970s, and gave it a sizable boost with its Technical Distributor (TD) program five years ago.

Indeed, Intel makes so bold as to suggest that it oiled the wheels for others' distributor programs: "Most of our distributors agree that if we hadn't done TD, they probably

The rise of systems sales in industrial distribution



Source: Montgomery Securities

Tim Davis

PETER SNELL, director of reseller marketing for Wyse Technology: "It's been our experience that [distributors] have been very strong partners"

Tim Davis

wouldn't have been as attractive to DEC," boasts Roach.

The TD program provides special incentives for distributors — up to 30% higher margins if they comply with all conditions, such as technical training by Intel, aggressive sales quotas and most controversial of all — distributor salespeople dedicated to Intel product.

Some say the program is too tough by far. Argues one Intel distributor who asked not to be named: "Intel's systems are extremely unprofitable for a distributor. If Intel wants a dedicated resource, why don't they do it themselves? They know it doesn't make money, so they're trying to force it on distribution. The whole premise of distribution has always been sharing of the resources."

Wyle's Ozorkiewicz, another Intel middleman, says that the chip maker changed its ways early this year in response to persuasion from several distributors hurt by having to field dedicated Intel salespeople in limited markets like Utah. Intel product, he says, is now "one of the best opportunities in distribution;" on Intel's single-board computer, Ozorkiewicz claims that a fully qualified TD distributor can make margins averaging 6% to 8% higher than on comparable competitive products.

DEC's program — a consolidation of five earlier reseller arrangements — is far reaching. Announced in mid-March, the program sees the Maynard, Mass., computer giant giving distributors all of its end user and reseller accounts of $500,000 and under in annual value. Hamilton/Avnet, which gets to sell DEC's entire product line, except for its mainframes, is expected to provide about half of DEC's new distributor sales.

Major vendors are taking pains to avoid clashes between their direct sales teams and their distributors. Explains Roach of Intel: "We try to take the business through the most cost-effective channel." He says that if a distributor lands a big order — and some seven-figure deals are now in the works — Intel will not steal the business for its direct salespeople. In practice, the vendor's strategy usually involves an equitable split of the profits between its own salespeople and those of the distributor.

Distributors stumbled badly in the early days, trying to pitch computer products as if they were connectors and wondering what buyers meant when they asked technical questions. Distributors also got into trouble selling to end users, often believing that the salesman who sold to OEMs could hit up other markets too.

Distributors also botched up trying to sell to computer retailers: "Avnet tried to act as a master distributor selling the DEC Rainbow PC, and it was a disaster," says Frederick Wolf, an analyst with Mabon Nugent & Co. in New York City. And Pioneer took a bath in the same area before putting its Srepco consumer products division on the block earlier this year. One reason why distributors found retail hard going: the quality of credit from retailers was less than what they were accustomed to.

Distributors stumbled badly in the early days, trying to pitch computer products as if they were connectors

Much has changed. "Distributors have spent quite a bit of time and money to educate themselves about the systems market," comments one supplier. Commitments to systems sales have been made in the boardrooms of top distributors, and many have established separate businesses with separate sales staffs to sell computer products. Players like Hamilton/Avnet, where a third of the 700-strong salesforce does nothing but sell computer equipment, have built teams of engineers to back their salespeople.

Ducommun has one of the most clearly defined segregations. Its Kierulff Electronics unit sells about a third of its product to OEMs, while sister divisions DDS and MTI Systems Corp. handle VAR and end-user sales respectively. AT&T and DEC both utilize two or more Ducommun units.

Distribution "diskoveries"

Today it is conventional for systems vendors to utilize distribution, often as a means to get in early in customers' design cycles. "I think it's very important early on to develop a distribution channel," says Finis Conner, chairman of Conner Peripherals Inc., a San Jose start-up founded only last year to make 3.5-inch Winchester disk drives. Conner expects up to 15% of his sales to come from distribution next year, and perhaps 25% by 1989.

Another drive maker, Seagate Technology of Scotts Valley, Calif., pushes about 15% of its product through distributors. At tape-drive company Archive Corp. of Costa Mesa, Calif., the ratio is the same, although it is expected to climb. And at terminals titan Wyse, one-fifth of the top line can thank distribution.

Evidently emboldened by successes with commodity computer products, distributors are now starting to sell to VARs and even to end users. Even Anthem, the most profitable of all

ROBERT THROOP, chief executive of Anthem Electronics: "There have never been any problems with growing; the problem's been making money"

distributors and a stalwart of OEM subsystem sales, is putting together a VAR program.

The profit potential is better — from 5% to 8% better than OEM computer systems sales since much more customer handholding is required, according to Wyle's Ozorkiewicz. And the growth opportunities are substantial. Notes Toby Mack, executive vice president of the National Electronic Distributors Association (NEDA): "The huge base of VARs that has emerged has become a natural constituency for distributors."

Wyle now has a VAR marketing channel which yields over 20% of its computer-systems trade, with higher percentages to come. For Arrow, the figure is over 35%. Vendors expect to benefit from distributors' vaulting VAR business: Archive has designed a tape drive specifically for that channel, while Intel already has 25% of its distribution sales coming from VARs.

Other distributors that feel they can add some value — and profit — themselves. In May, Arrow signed with IBM to sell the new Personal System/2 desktop computers nationwide to end users. Arrow will configure the package with software for vertical markets.

Others are probing into end-user sales: under DEC's new program, Hamilton/Avnet is an outlet for minicomputers; indeed, the distributor claims that end-user business will make up as much as a third of its DEC sales this fiscal year.

At this point, distributors are wandering into dangerous territory. Some observers caution that end-user business can involve leasing arrangements that put the financial burden on distributors; others believe that clashes between the channels are inevitable as the distinctions blur: "It's hard to sell to VARs and also be one," cautions NEDA's Toby Mack.

Terminals vendor Wyse proposes a solution: peace through partition, where distributors add hardware value, and VARs add software to tailor the equipment to vertical applications.

With such faith from suppliers, and such demand, it's a wonder that the systems business is not universally profitable for distributors. While participants like Anthem and Wyle show what can be done in the way of profits, many others remain strapped by computer products' inherently lower gross margins. "Margins run in the high teens rather than the low twenties," reports Arrow's Kaufman.

Pricing issues

Regrettably, systems' high average selling prices, few part numbers and fast inventory turns — Anthem claims up to 10 turns annually while Arrow consistently shifts the shelves six or seven times a year — are no match for margins that sit four or five percent lower than for semiconductors.

Alongside Arrow, Ducommun's DDS and Kierulff divisions remain in the red, and do not expect to climb out until later this year. (Interestingly, Ducommun's other unit, end-user marketeer MTI, is well into the black.) Lex Service Plc's David Jamison Carlyle Corp. unit, now renamed Lex Computer Systems, is working hard to curb losses; in 1986, a major restructuring that involved a 20% salesforce cut helped bring the negative earnings back down to $2.5 million from $4.8 million in 1985. Managed properly, the new DEC program may be of considerable benefit to Lex.

DDS and Kierulff are working hard to clean up their line cards, shutting down lackluster lines for more promising ones like Seagate disk drives. Arrow is doing likewise. The moves are intended to do what distributors should have been doing all along: focusing large doses of sales effort on fewer customers.

Ducommun is also expanding its MTI unrit from 10 to 18 locations in a bid for more end-user action, and hopefully, to double sales over the next couple of years from today's $50 million level.

RALPH OZORKIEWICZ, president of Wyle Laboratories' Electronics Marketing Group, sees his systems sales expanding 30% a year at least over the next three years

Others are stepping up the pace to make sure that systems sales sparkle. Wyle, which also stocks DEC's MicroVAX II minicomputer, Wyse's PCs and terminals and NCR Corp.'s Tower computer, is launching a recruitment drive; over the next two years, it expects to hire more than 100 new salespeople — two-thirds of them right out of college. At present, 20% of Wyle's 200-strong salesforce handle computer products only, and another 20% sell both components and systems. The hiring binge should bolster the ranks of systems salespeople by 25% by 1989.

Likewise at Pioneer-Standard, where analysts say sales of Western Digital Corp. disk controllers, Maxtor Corp. optical disk drives, Texas Instruments Inc. printers and much else will do a lot to propel sales about 5% faster than the industry average. Says chairman Preston Heller Jr.: "[Our salesforce head count] will climb in advance of sales, to drive sales."

With the pundits predicting that computer products will fuel much of the 12% to 13% annual growth in distribution sales, it is tempting to think that distribution's troubles are over. Too bad that profits do not automatically follow sales. Concludes Montgomery Securities analyst Neff: "Looking at the business prospects for this year, the alternatives are fairly clear: this industry either needs more sales or fewer competitors." ☐

PERIPHERALS

The Year of the Rabbit and the 3.5-inch Winchester

This year, for the first time, low-end 3.5-inch disk drive shipments are expected to exceed 5.25-inch models

By John Kerr

In China, 1987 goes down in the history books as "The Year of the Rabbit." In the United States, disk-drive makers may remember it better as "The Year of the 3.5-inch Winchester."

The label is apt: a myriad of indicators point to this as the year when the tiny fixed-disk drives come into their own at last. "Up, up, up!" is how William Schroeder, president of Conner Peripherals Inc., describes demand for the 3.5-inch units that his San Jose-based company was founded last year expressly to build.

It remains to be seen, however, whether the drive makers can convert that demand into production; at least one vendor of thin-film media — the disk platters themselves — believes high-performance media will be in short supply for awhile.

Production constraints aside, the outlook is hard to beat — despite some resistance among computer users to convert data stored on 5.25-inch drives to the new format. Indeed, there is still a question whether or not "the 3.5 will be the only low-end drive," says Allen Herder, marketing manager for personal mass storage products at Hewlett-Packard Co. "Clone makers are typically driven by price. I don't think they care [which format they use]."

Nevertheless, Los Altos, California-based market researcher Disk/Trend Inc. predicts that in 1987, worldwide original-equipment manufacturer shipments of low-end 3.5-inch units — below 30 megabytes of capacity — will for the first time outpace those of the equivalent 5.25-inch drives, a significant milestone for the mini mass-storage machines.

Another data digger, InfoCorp of Cupertino, Calif., believes that by 1991, the mini-Winchesters will account for more than 70% of the rigid drives used on computer systems priced between $500 and $6,000.

The outlook is hard to beat, despite some resistance among computer users to convert data stored on 5.25-inch drives to a newer format

Observers also point to burgeoning after-market demand. According to San Jose research firm Dataquest, worldwide shipments of 3.5-inch rigid subsystems for the after-market will grow nearly 25% annually, from 833,000 units last year and roughly 1,250,000 this year, to 2,023,500 in 1990.

Product blizzard

Not surprisingly, there has been a blizzard of recent product announcements heralding the high-performance miniature Winchesters to come — 3.5s with Porsche-like access times as sleek as 25 milliseconds (ms) and enough memory to make an elephant blush. Most are geared to the demands of the latest personal computers driven by Intel Corp.'s 80386 microprocessor.

Consider too that blue-chip OEMs of PCs have started to design 3.5-inch bezels — spaces for the small drives — instead of popping the 3.5s into 5.25-inch holes, and it is apparent that the next logical step in mass-storage downsizing — from 5.25- to 3.5-inch form factors — is well under way.

Says William Hake, vice president for 3.5-inch products at Longmont, Colorado-based MiniScribe Corp.: "We've been waiting for a couple of years for this point. You could say this is the year the 3.5-inch form factor has finally arrived."

Meanwhile, British firm Rodime Plc, a pioneering 3.5-inch vendor, is angling for its share of the market. Having been Apple Computer Inc.'s longtime sole source for 3.5-inch 30MB Winchesters, Rodime this spring watched Apple qualify another vendor — reportedly archrival MiniScribe. Last year Apple provided 40% of Rodime's sales. But outwardly, the company is sanguine. "We're basically shipping as much as we ever were," says Gary Janz, Rodime's director of marketing. "Apple has always been pleased with the quality of our products."

Interest in 3.5-inch rigids is quickening pulses on Wall Street. Declares Andrew Neff, an investment analyst with San Francisco brokerage Montgomery Securities: "We believe that 3.5-inch Winchester disk drives will become the next major area of investor attention [and opportunity] in the data-storage industry."

In a recent report, Neff estimates that revenue from shipments of miniature Winchesters could more than double in 1987 to top $1.4 billion, and grow at a compound annual rate of over 60% through 1989.

Apple was one of the first OEMs to accept the format as standard in its Macintosh PCs. Analysts now estimate that 80% of the Macintosh SEs are shipped with 20MB 3.5-inch hard drives aboard. With Macintosh family sales on a roll, the company expects to complete its plan to migrate all of its 40MB hard drives from the 5.25-inch to the 3.5-inch size by February 1988, and to push onward to 80 MB six months later.

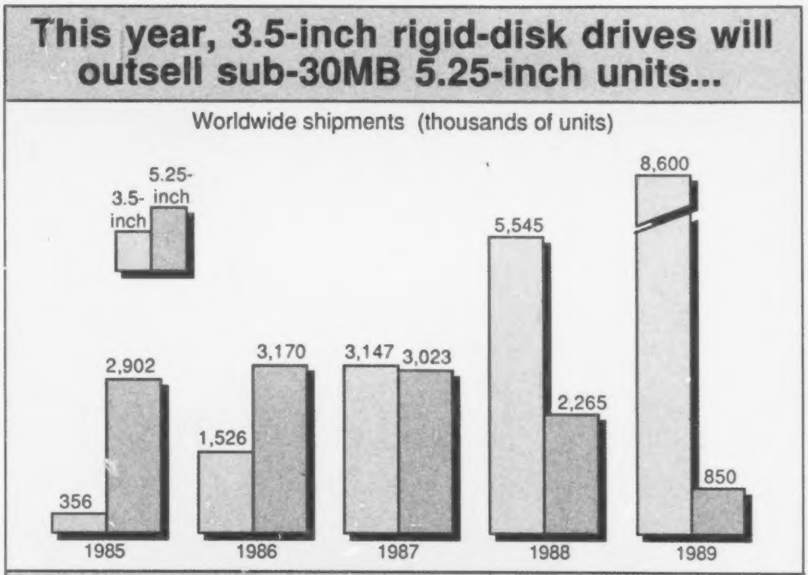
Compaq Computer Corp. also has recently backed the breed. Its Portable II and Deskpro 286 machines feature 20MB minidrives, and its Portable III uses 20MB and 40MB models with data-access times less than 30 ms. All of these drives are made by Conner Peripherals, in which Compaq has a 50% equity stake.

No prizes for guessing the source of the most significant endorsement of all — the one that is stimulating enquiries and bookings at several 3.5-inch vendors. When IBM unveiled its Personal System/2 PCs in April, it bestowed the Big Blue benediction upon the form factor by including 20MB versions in the System/2 Models 30 and 50.

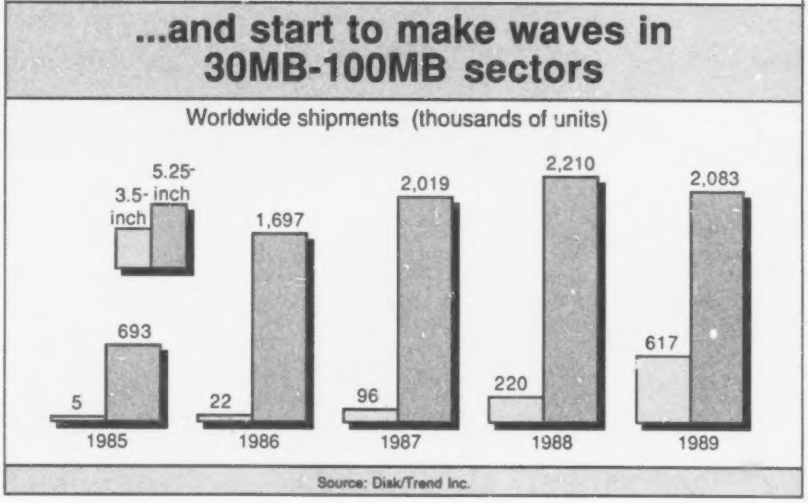
And, although the engineering workstation market is still geared toward 5.25-inch, there is rich promise for the new breed of high-performance 3.5s. Mountain View workstation leader Sun Microsystems Inc. expects to begin designing in the 3.5-inch drives in "less than a year and more than six months" according to Jon Garman, director of engineering of the workstation division.

Sun won't employ the slow 20MB models featured in IBM's new PCs. "We can't build standalone workstations with less than 100MB on disk," explains Garman, adding that such units typically need drives with at least five times their substantial onboard memory.

Smaller workstation dimensions are also critical. "Believe it or not, everybody worries about footprint," declares Garman. Keeping the center of a large workstation screen at the users' eye level is a vital consideration, and one that will be met more easily with the little drives.


This year, 3.5-inch rigid-disk drives will outsell sub-30MB 5.25-inch units...

Worldwide shipments (thousands of units)


...and start to make waves in 30MB-100MB sectors

Worldwide shipments (thousands of units)

Source: Disk/Trend Inc.

But the technical feature that attracts most systems builders is the low power requirement of the 3.5-inch drives, which often eliminates need for cooling fans and so further reduces space. Half-height 5.25-inch drives can devour up to 25 watts, while the minirigids sip 10 watts and less. Conner already claims just 6 watts for its 40MB model — critical for use in portables and valuable to customers like Apple that already want less than 5 watts.

Access times — the time it takes to tap into data on a disk — are also tightening up: where the lower end 3.5-inch units are happy to get at the data in 80 ms, breathless newcomers are there in less than 30 ms. Compaq is using rapid data access as a selling feature to differentiate its PCs. "When you get into networking, faster access times become important," says MiniScribe's Hake, whose 8425F 20MB 3.5-inch model accesses in 40 ms.

The 3.5-inch Winchesters are also said to be more reliable than their larger cousins. John Hagerman, product marketing director at San Jose-based Priam Corp., which plans to unveil a high-end unit early next year, points to mean times between failures climbing above 30,000 hours and nonoperating shock resistance as high as 75 g compared with the 20 g common to 5.25-inch models. (A "g" is the unit force to which a body is subjected during acceleration.) Partly ,this is due to the very large scale integration chip sets used to pack more drive into less space; partly, it's an attempt to meet the harsher environment today's desktop PCs face.

But why are 3.5-inch drives only emerging now? The form factor is already several years old. The answer is fourfold:

- First: Mainstream 5.25-inch rigids

are migrating from 50MB to 100MB capacities, pulling 3.5-inch into their 20MB to 40MB wake, according to InfoCorp researchers.

- Second: It takes blue-chip backing to provide some market momentum — and there's none bluer than Big Blue. "What made the industry go to 5.25-inch was IBM," recalls Montgomery Securities' Neff.
- Third: Then there are technical factors: the thin-film media needed to pack the same volume of data onto smaller disks were not available in reliable quantities, and new downsizing manufacturing techniques — use of surface-mounted components and custom chips — took time to evolve. Also, the Small Computer Systems Interface (SCSI) is emerging as a dominant standard and it is one that vendors of 3.5-inch drives have been quick to back.
- Fourth: Time was the final ingredient in forging the right market attitude: the complex blend of vendor pressure and customer demand that defines the psychology of the market and declares that the next downsizing stage has arrived.

Pricing issues

That same psychology is driving prices of 3.5-inch Winchesters downward. At its most elementary, it states that the smaller the drive, the lower the unit price. MiniScribe's Hake says 5.25-inch half-heights still have a cost advantage; he cites a $10 gap between a 68 ms, 20MB 3.5-inch model and its larger half-height cousin costing perhaps $240 in OEM volumes. "In the second half of this year you'll see parity," says Hake.

New 3.5-inch Winchesters are emerging with sub-30 ms access times and huge storage capacities

Brand	Model	Capacity (megabytes)	Access time (milliseconds)
Maxtor	LXT-170	170	20
Conner	CP3100	100	25
Conner	CP340	40	29
Rodime	3085S	70	28
Rodime	3070S	58	28
Rodime	3057S	45	28
Seagate	ST157N	45	30

Source: InfoCorp

Participants expect pricing of low- and midrange units to erode at a now-familiar 10%-plus annually, and they are preparing for it. "In the first full year of production you've got to be competitive with 5.25. The second year, you've got to have some very, very aggressive pricing targets and know how to get cost out of your product," says Skip Kilsdonk, marketing director for Maxtor Corp., a San Jose maker of very high performance drives.

Maxtor is one of the latest to enter the 3.5-inch game; it joins a pack of over two dozen players, but will compete against only very few in the high-end with the 170MB, 20-ms LXT-170 unit it unveiled this spring. "We plan to offer everything in 3.5-inch that we offer in 5.25-inch," says Kilsdonk. Although the new drive is just beginning customer evaluation, Kilsdonk estimates that he will ship over 100,000 of them in 1988. By 1990, he predicts, 40% of his sales will be from 3.5-inch products.

Seagate Technology of Scotts Valley, Calif., has also shown its hand with its 20MB model ST125 and 30MB ST138, both with 30-ms access times. Quantum Corp. of Milpitas, Calif., is readying its own contender; Chatsworth, California-based Micropolis Corp. is thinking about it; and Conner is doing it already.

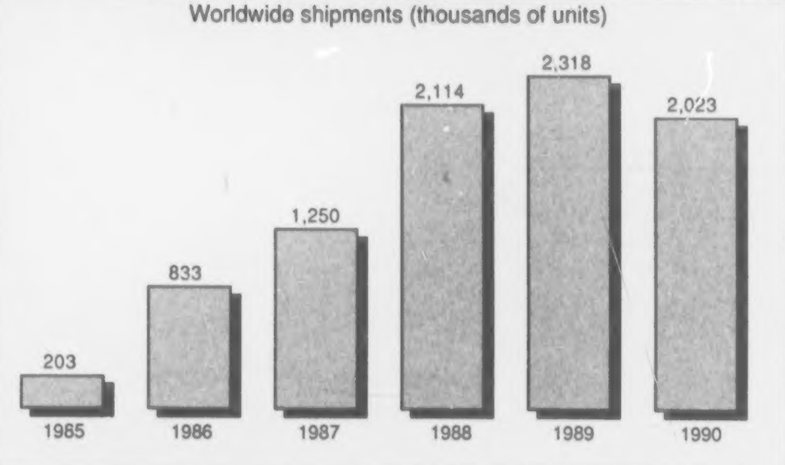
Boasts founder and disk-drive guru Finis Conner: "We did more sales in our first quarter than Seagate did in their first year of equivalent sales." Those sales: $10 million in the first quarter — 75% from stockholder Compaq — and unit sales that may make Disk/Trend's projections look positively cautious.

Conner also claims to be operating profitably, with gross margins "in the 30 percents." He expects present production of 1,000 40MB and 100MB models a day to double by this fall. The 40MB drive lists for under $600 in volume; Conner is keeping costs down with undisclosed methods of testing during manufacture.

But 3.5-inch drives will not go anywhere without disks and recording heads. Makers of thin-film media had early difficulty maintaining quality in high volume, and may still have problems meeting demand for the new high-performance mini-drives. "There just isn't enough good quality high-capacity media out there in the industry right now, and I don't think there's going to be enough for a year and a half or two years," says Stephen Johnson, president of Milpitas-based media maker Komag Inc.

That is apparently open to debate. Fellow media manufacturer Kenneth Lee, vice president for product development at neighboring Domain Technology Inc., cites a study showing that the combined top five domestic media suppliers can exceed worldwide demand by 20% to 30% by 1990 with their installed capacity. Komag is working toward it: it added a third 1.2 million disks-per-year line in April, has begun a fourth, and is placing orders for equipment for fifth and sixth lines. ☐

After-market demand heats up for 3.5-inch drives



Source: Dataquest Inc.

ELECTRONIC PUBLISHING

From Gutenberg to PageMaker in five easy centuries

The market for corporate electronic publishing systems is just getting under way in Europe but prospects are promising

By Jack Gee

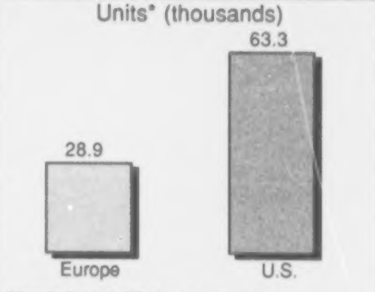
In the early 1980s, Americans flocked to their local stores to buy microcomputers. Today, many of the acquisitions from that stampede gather dust in attics and closets. But, while the micro craze swept the United States, the Europeans adopted a wait-and-see approach. In the next few years, we could witness similar contrasting behavior patterns in corporate electronic publishing systems (CEPS).

Slow to be convinced that the personal computer was here to stay, Europe has now become a stable, steady market. It is also a market unmarked by the disenchantment among users which, in the United States, sent some PC manufacturers clamoring for Chapter 11 and mothballed semiconductor foundries. The same cautious development trends are likely to emerge in the European market for CEPS hardware and software packages.

However, Europeans do not underestimate the potential of these systems, which combine a high-definition monitor, keyboard/graphics tablet, processor, disk storage and laser printer. "This lively interest is not surprising when you remember that the printing press was invented in Germany by Johannes Gutenberg over 500 years ago," says Yves Stern, president of Italiques, a French computerized typesetting company which is also a partner in a desktop publishing venture.

This year, European businesses are likely to spend about $150 million on desktop publishing, according to Wharton Information Systems, a market study group based in London. And even with Europe's slow awakening to CEPS' potential, Wharton says that CEPS looks set to capture a $1.5 billion European market with sales of over 140,000 systems by 1990.

In 1986 Europe ran second to the U.S. in CEPS



*Nondedicated, PC-based systems

Source: Dataquest Inc.

As with the PC five or six years ago, Europe has initially turned to the United States for much of its CEPS hardware and software. But, since leading European microcomputer manufacturers can offer high-definition screens, dependence on the states for this hardware is no longer as strong as it was for the PC.

The Europeans are also considerably less dependent on American CEPS software than they were for the application packages for the first business microcomputers. However, Apple Computer Inc. is trying to repeat its U.S. success and conquer Europe's CEPS market with the Macintosh PC in association with its own Laser Writer printer and Aldus Corp.'s PageMaker publishing software.

Mac attack

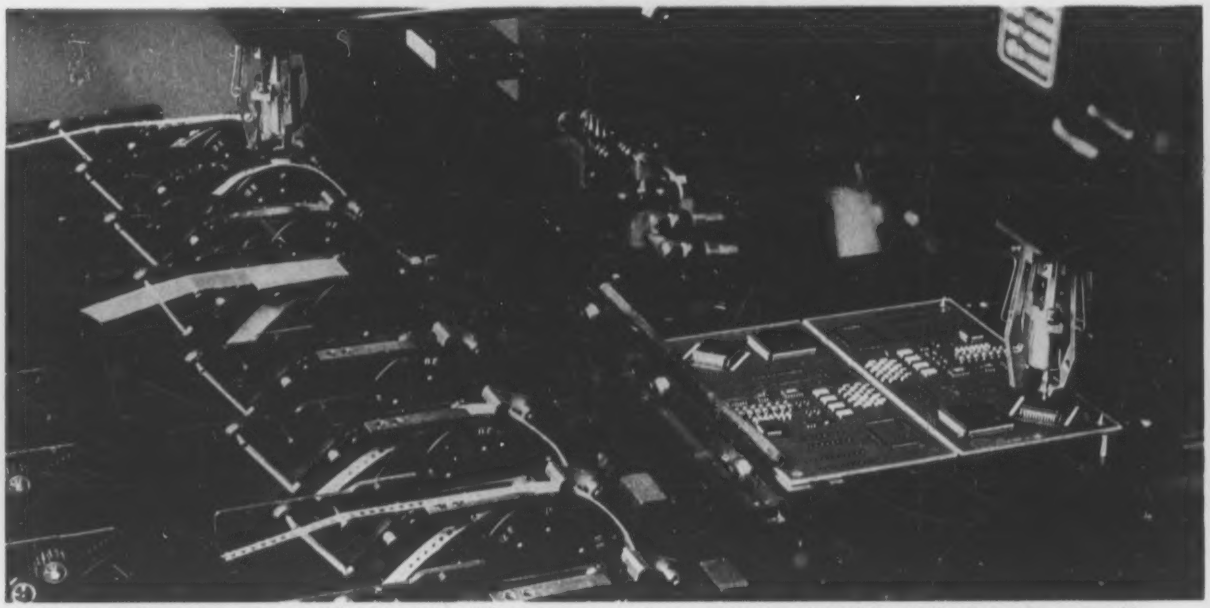
According to Intelligent Electronics, the European microcomputer market research firm which was recently acquired by Dataquest Inc., Europe bought 15,000 Macintoshes last year with as many CEPS software packages — and half of these were Pagemakers. Gordon Curran, associate director of Intelligent Electronics, which has kept its name under U.S. ownership, says: "During the first half of 1987, as many desktop publishing packages have been sold in Europe as in the whole of 1986."

In contrast with the advent of the PC, when the United States was slow to produce application software in European languages, U.S. suppliers have hastened to customize their CEPS programs so as not to lose this market to Europe's own software houses. Alan Clemmetsen, associate director of Dataquest's European Printer Industry Service, says: "A race is on between the U.S. customized packages and the locally produced software in Europe."

But this contest demands stamina. Jo Cohen, a desktop publishing consultant in Paris says: "Whether it's the Americans adapting their software for Europe's markets or the Europeans writing their own, page description language is extremely difficult, time consuming and costly. Our medley of accents and varying rules about hyphenation make this task particularly complex."

Europeans' suspicion of what they regard as an impulsive American attitude toward new gadgets partly explains their relatively slow acceptance of CEPS. Another reason is Apple's failure in Europe — except in France — to match the impact which its successive generations of PCs have had in the United States.

Dataquest's Clemmetsen predicts that CEPS will become a genuine force in Europe only when IBM clearly commits itself to this market. He says: "Now that PageMaker and Xerox's Ventura desktop publishing packages have been adapted for the IBM PC, we can expect rapid growth. But, in contrast with its strategy in the U.S., IBM has not yet declared its hand in CEPS in Europe." □



WITH THE YEN hovering at about 150 to the dollar, U.S. equipment carries an attractive price relative to the Japanese competition

Photograph courtesy Universal Instruments

EQUIPMENT

Dynapert and Universal go for the Asian gold

The largest manufacturers of PCB assembly gear are shifting their perspective to include the Far East

By Mark Mehler

The appreciation of the yen relative to the dollar has given U.S. suppliers of printed circuit board assembly equipment a window of opportunity into Hong Kong, Korea, Singapore and Taiwan, where much of the world's consumer electronics assembly occurs. With the yen hovering at about 150 to the dollar, and expected to stay at that level for some time, U.S. equipment — both through-hole component inserters and surface mount component (SMC) pick-and-place machines — carries an attractive price relative to the Japanese competition.

In an attempt to grab that opportunity, the two largest U.S. assembly equipment makers, Universal Instruments Corp. of Binghamton, N.Y., and Emhart Corp.'s Dynapert Division in Beverly, Mass., which together control close to half of the estimated $450 million worldwide merchant market, are introducing a flurry of new products aimed at meeting the Far East requirement for high speed, accuracy and reliability.

Asia is where the action is because, as many industry experts say, the "Five Dragons" of the Far East — Hong Kong, Japan, Korea, South Korea and Taiwan — accounted for about 45% of the $450 million in PCB assembly equipment shipments in 1986. The United States only accounted for about 35%, experts say, followed by Europe at 15%, and the rest of the world, primarily Brazil and Mexico, with 5%.

Among the seven new products unveiled by Universal so far this year is a surface-mount chip placement system designed to turn out high-volume boards for consumer toys and appliances. Dan Mortland, Universal's director of product marketing, says several additional products will also be rolled out soon, all targeting the Pacific Rim market.

Meanwhile, Dynapert, which has had a large share of the Asian market for through-hole insertion equipment, sees the present currency situation as its chance to sell its first SMC placement systems in that part of the world. Toward that end, the company recently introduced a high-speed placement machine.

The two U.S. leaders, of course, have plenty of competition. Charles-

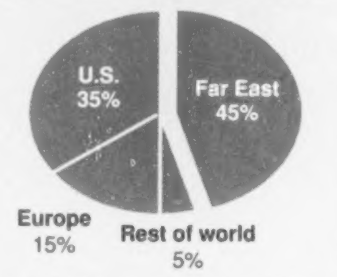
Henri Mangin, an industry analyst in Old Lyme, Conn., says at least 75% of the Pacific Rim market consists of high-speed "chip shooters," made by Fuji, Panasonic, TDK and others. Until recently, these systems had limited capabilities, primarily in handling resistors and other commodity parts. However, the new generation of Japanese equipment reportedly has the flexibility to mount small-outline integrated circuits (SOICs) and other sophisticated surface mount devices. Panasonic's MK-2 machine, for example, can place jellybean chips and all SOICs on 8mm-to-24mm tape, at speeds of up to 18,000 parts per hour.

Mangin also says the old claim that Japanese equipment lacks flexibility no longer is valid. Although he agrees that the rise of the yen gives (Dynapert and Universal) an edge, he doesn't see them challenging Japanese domination of the roughly $120 million to $130 million Asian market for SMC systems.

"Regardless of the value of the dollar, the U.S. companies are only just entering the market, and they have a big lead to overcome," says Mangin. "It's [analogous] to cars. A million people buy Mercedes each year. The fact that Cadillac is a little cheaper doesn't mean it will beat Mercedes at its own game."

At least one large user concurs with that assessment. Robert Todd, chairman and president of Flextronics Inc., a contract assembler with manufacturing facilities in Hong Kong, Singapore and the United States, says his firm just bought two Fuji high-speed SMC pick-and-place machines for its Asian operations. "In our business you don't buy the first machine," says Todd. He adds that before Asian contractors or original equipment manufacturers "feel comfortable" with U.S. equipment, American suppliers must build solid service presence in Asia.

Worldwide merchant market for printed circuit assembly equipment



Total 1986 market: $450 million

Source: Industry estimates

Dynapert and Universal are increasing their penetration of the Far Eastern market

Asian agents

Universal's Dan Mortland says that the company has opened a support office in Hong Kong to supplement its Japanese representative, Hakuto, and it is considering additional sites for new service facilities. "Hakuto has been very strong as a sales agent," says Mortland, "but we recognize the need to offer all the support we can." Mortland says that while the rising yen has given Universal the impetus to pursue the traditional Japanese niche in high-volume consumer electronics assembly, in a broader sense the Asian thrust is part of a corporate commitment to compete more effectively in the global marketplace. In the past year, according to Mortland, 60% of Universal revenue was derived from offshore sources. In past years, offshore customers accounted for 40% or less.

Christopher Sears, product manager for through-hole assembly equipment at Dynapert, insists that the Massachusetts company has been the leader in the Far East high-volume through-hole market since the early 1980s, and now has about 60% of that business. Dynapert sells direct in Japan through its own subsidiary there, and Sears says that presence, coupled with the "currency impact," will help Dynapert launch its new 14,000-parts-per-hour SMC machine in Korea and the rest of the Pacific Rim.

"Now that onshore Japan is dead, we're looking at Korea and Taiwan as our biggest growth markets," says Sears, adding that the Far East already delivers more than half of Dynapert's total revenue.

Sears says Dynapert's new pick-and-place machine, at about $300,000, is cost-competitive with the Japanese approach, which involves selling "broken apart" machines, one for dedicated applications (resistors, capacitors), the other for lower speed placement of ICs. "We still see the Japanese competing in a niche market for simple systems that do a finite range of parts with minimum moving mechanisms, and do it well," says Mortland.

The two industry leaders, however, will get an argument, at least, from Michael Ruiz, western regional sales manager for Panasonic's Industrial Equipment Division. Ruiz points to his company's success at penetrating leading-edge customers in the United States. Apple Computer Inc., IBM, Motorola Inc., Rockwell Interna-

U.S.-MADE EQUIPMENT, such as Dynapert's newest surface-mount insertion machine, is targeted at the Pacific Rim market tional Corp. and Xerox Corp., all of which are acquiring high-speed surface mount capability for strategic purposes, are Panasonic customers, says Ruiz.

The U.S. equipment makers have their own niche in high-reliability machines for mounting advanced circuits, and midrange flexible systems, Ruiz concedes. But in the fastest-growing market for flexible, high-speed systems, he argues, it is the U.S. suppliers that face the "credibility gap" in technology.

"The yen levels may not come back and this presents them with a window in Asia," Ruiz adds, "but how long that window will last is another question. The U.S. companies are at the beginning of a long learning curve. When they've completed it, will the opportunity still exist?"

Mehler is a New York-based business writer.

TEST

The lure of the low-end board test market

Competition is making medium-sized ATE companies look to the low end of the printed circuit board test market

By David Card

Price wars in the crowded middle tier of the automatic test equipment market are forcing some suppliers to look for opportunities in the low-cost board test business. But the field is already crowded.

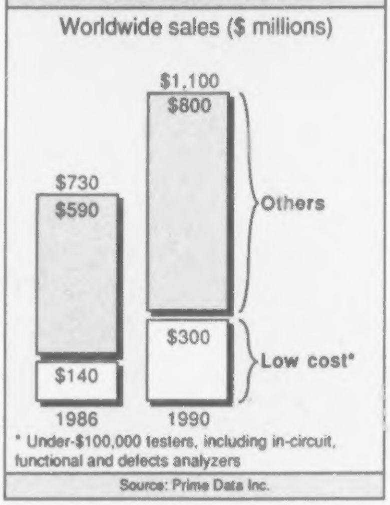
British supplier Marconi Instruments Ltd. has more or less given up on the midrange U.S. ATE market. "To compete, you have to give [the equipment] away," says William Bean, vice president of Marconi's U.S. sales arm in Allendale, N.J. "You start out saying [your product] costs $150,000 but then, magically, another demo model is suddenly available for $70,000."

"There will still be a middle market for in-circuit testers," agrees Craig Pynn, marketing vice president of Zehntel Inc., Walnut Creek, Calif., but "it won't be a growing market."

Currently, in-circuit testers, which test the individual components of a circuit board, are in the middle of the ATE price spectrum. At the high end are combinational testers, costing half a million dollars and up; they combine in-circuit techniques with functional testing of the board. At the low end are cheap functional testers, sort of pass/fail systems, and manufacturing defects analyzers (MDAs). Defects analyzers catch short or open circuits.

Marconi has a line of in-circuit testers that has been largely unsuccessful in the United States, according to Roy Lester, general manager of Marconi's Automation Division in St. Albans, England. "What we've done in the U.S. is concentrate on Checkmate," he says, referring to Marconi's 2-year-old low-end tester. Checkmate is a modular system that can be configured as a cheap in-circuit or functional tester. It sells for around $65,000, and Marconi has sold $9 million worth, Lester says. This year, the company also introduced a defects analyzer.

Low-cost testers' share of total ATE market



* Under-$100,000 testers, including in-circuit, functional and defects analyzers

Source: Prime Data Inc.

Lester says that Marconi tried a big in-circuit push in the United States a few years ago but was clobbered by the three-headed club of "competition, recession and oversaturation." As a result, Marconi only sold about 85 testers in the states. "There is still some residual business, but now we are focusing on a market where there is less competition," Lester says.

Plenty of products

Meanwhile, that market is already filling up with competitors. One is Zehntel's new low-end in-circuit tester, the 1800. Zehntel's Pynn says that it will face competition from three areas. He thinks customers will choose either MDAs or what he calls the "benchtop" testers of Marconi and others. Or they'll choose stripped-down models from the bigger in-circuit ATE companies, such as GenRad Inc. and Hewlett-Packard Co. — or Zehntel for that matter. But, Pynn says that Zehntel changed the architecture completely for the 1800.

If Zehntel's customers can use custom chips on their boards, then why couldn't Zehntel? Pynn asks. A redesign, incorporating custom chips from National Semiconductor Corp. got a $23 dollar driver/receiver system, hundreds of which populate an in-circuit tester, down to $14, Pynn says. Still, the 1800 is less flexible in terms of what families of logic it can handle. "We've always offered lots of options," Pynn says. "But this one's price list fits on a single page. Sort of like the Model T — everything you need, you get. Everything else, you don't need."

Zehntel will have to change its style of selling, since the 1800's lower gross margins will not support the "traditional 18 sales calls" common to the ATE business, according to Pynn. He is inaugurating a telemarketing campaign, and hopes to leverage tester sales from a videotape and even a book that he wrote on test strategies. It is a whole new world for Zehntel. "We're going to try to bring some of the economies of scale of the instruments business," Pynn says. "It's really just an instrument."

There are, of course, some very established instrumentation companies at the low end already. John Fluke Manufacturing Co. of Everett, Wash., sells its 9000 series of modular, functional testers into the production test floor where ATE rules. Hugo Draye, a Fluke marketing group manager, says that the 9000 is generally used as a "trouble-shooter," rather than a production tester. After a conventional tester fails a board, the $30,000

Fluke machine is used to track down the failure.

Fluke also makes a defects analyzer, but Draye says that the company's efforts are concentrated on the new generation of the 9000 series, the 9100, rather than on the 4-year-old analyzer. "We want to maximize the efficiency of our product line," Draye says, rather than focus on any one branch of ATE. The defects analyzer, incidentally, has not been exactly a runaway success for Fluke, Draye admits. He says that he only sells 15 to 18 analyzers in any given year.

Fluke has also failed to penetrate the Japanese market with its defects analyzer, even though MDAs in general are more popular in Japan than in the United States, Draye says. But in reference to the U.S. market, he says "MDAs are falling back into a favorable light." Draye continues: "The other thing that will help the MDA market is the swing back to functional test at the high end." Combinational/functional testers, Draye reasons, are so expensive that companies will want to catch faults to avoid tying up the big machines at the end of the line. MDAs can be used to diagnose the failures for repair.

Draye suggests that companies wanting a low-cost test solution should buy the 9100 for testing boards during the development stage of a product. Then, when they ramp up production, they can add a number of low-cost testers rather than starting from the beginning with one expensive ATE system geared for high-volume testing. That way, they can depreciate the cost of one cheap tester during the development time when they have no product revenue, and add capacity when they do.

Start-ups galore

Three-year-old Support Technologies Inc. of Portland, Ore., originally cast itself as a company in the service tester business. But half of its $2.5 million in sales last year were from manufacturing, says Support president Alfred Hahn. "We're officially at the low end of the regular ATE business," Hahn says of his functional tester. The fixture that Support sells to allow boards to plug into its tester is the same one GenRad uses, from Pylon Co., Hahn says.

There is one thing Support is doing differently than the conventional ATE companies. "We're moving this product upscale," Hahn says. With the fixtures suitable for volume testing, Support's testers can cost $50,000 to $80,000.

As Support is aimed primarily at testing digital boards, Summation Inc. of Kirkland, Wash., was aimed at testing analog boards. But, this year, the company added digital capability that should bring it head-to-head with Fluke, Marconi and Support. Still, Summation's marketing vice president, Michael Thiemann, says his company is really in the custom-ATE market, replacing racks of instruments rather than ATE systems.

Not coincidentally, that is one of the markets Zehntel is after with its new tester, according to Zehntel's Pynn. That and "smaller companies that don't want to invest all those bucks in ATE," Pynn says. Summation's Thiemann seems to echo Pynn: Customers "turn to us when they can't buy — or buy in a cost-effective way — a turnkey ATE system." ☐

CAD

Upward mobility in circuit board design

Workstation price wars are making PCB CAD vendors seek alternative hardware solutions at the low end

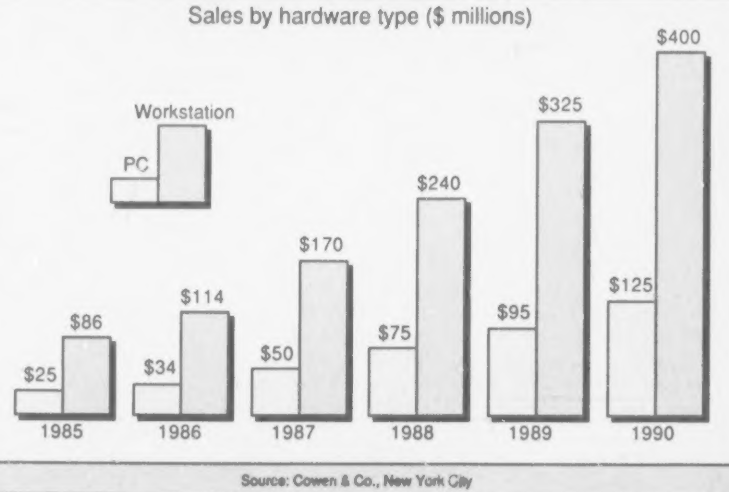
By David Card

A handful of smaller companies have made their fortunes riding the coattails of the IBM personal computer. Typically, these firms sold $10,000 circuit-board design software to engineers unwilling to fork over the $50,000 to $100,000 that it cost for a 32-bit workstation system. But now workstations are nearly as cheap as 16-bit PCs, and computer-aided engineering and design (CAE/CAD) software packages can be had for about $500. What's a company to do?

Move upscale. Companies in the $5 million to $20 million range — companies like CASE Technology Inc., FutureNet Corp. and Viewlogic Systems Inc. — are jumping on the bigger hardware. Actually, jumping is not exactly an accurate term. Being dragged grudgingly is more like it.

"We've had our noses rubbed into the fact that customers want a broad spectrum of products," complains Bruce Gladstone, executive vice president of FutureNet in Chats-

Worldwide CAD market for printed circuit boards



Source: Cowen & Co., New York City

worth, Calif. FutureNet was one of the first to offer PC software for design, back in 1983. Early this year, the company rewrote its software to run on VAXstation workstations from Digital Equipment Corp.

"We were getting weary of telling people that you can buy the PC AT with the same performance as the VAXstation, so now we're offering the VAXstation," Gladstone says. He claims that in reality, the performance is not much different, but the customer's "perception is reality." Other FutureNet execs say that the DEC hardware opens doors at some larger companies that would not look at a PC.

"Some customers believe that a workstation is the only way to do CAE," says Alain Hanover, president of Viewlogic in Marlboro, Mass., "They have a mental block." Viewlogic, too, worked its way up to DEC.

Workstation wars

The new pricing structure for workstations makes them an attractive alternative to the PC. In April, workstation maker Sun Microsystems Inc. slashed the price of its entry-level machine from $7,995 to $4,995, initiating a price war that Apollo Computer Inc., DEC and Hewlett-Packard Co. soon entered. "The PC has a better price/performance ratio, even with all the drastic price cutting," Hanover maintains. But he is perfectly realistic about customer demand: "If people are willing to spend it, we'll take their money." Hanover says that he added DEC to his IBM PC base because "we wanted to represent the two largest computer vendors out there in design automation. Apollo is No. 3 and Sun a distant fourth."

> With workstations now as cheap as 16-bit personal computers, it makes sense to write PCB software for higher powered CAD engines

Mountain View, California-based CASE Technology claims it was always a workstation supporter, according to president Kevin Kerns. Computer-intensive operations such as automatic chip placement and logic simulation fit the bigger machines, while schematic entry, the first step of the design process, ran on the PC. Kerns admits that 70% of CASE's business has always been for PC software.

CASE recently started offering schematic entry for DEC and Sun hardware. The transition was easy, Kerns says, because CASE originally wrote its software to run under the Unix operating system that controls most workstations. For PCs, CASE translated the software into DOS, the PC operating system of choice.

Personal CAD Systems Inc. of San Jose is one company that does not want to abandon DOS, according to president Douglas Stone. In fact, last year P-CAD aborted an attempt to get into the Unix business. Now Stone says that he might look at Unix again, particularly for Apple Computer Inc.'s new Macintosh II personal computer. But right now, he does not want to tread on the turf of the CAE workstation suppliers, particularly market leader Mentor Graphics Corp., whose software runs mostly on Apollo machines.

Stone wonders about his competitors' strategies. "What are they going to do, compete against Mentor? On Mentor's own terms? Without a DOS platform?" Stone asks. "The Unix-based people are going to come back with a networking strategy that will just plaster them." CASE, FutureNet and Viewlogic all insist that they have not abandoned DOS.

Stone estimates that IBM's in-

The CAE companies on PC software: No thanks

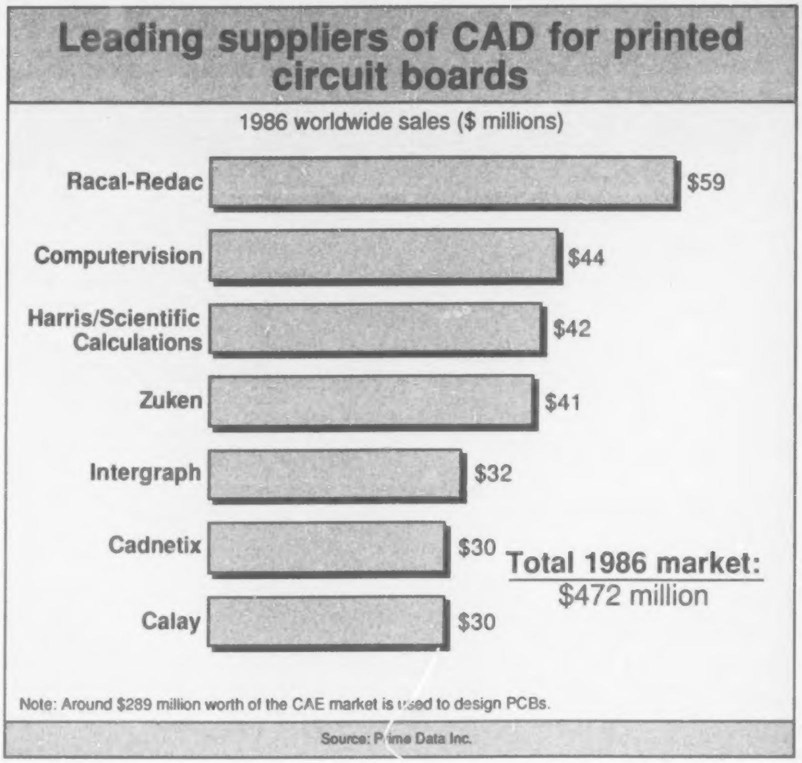
The CAE workstation companies are relative newcomers to printed circuit board CAD. But they, too, believe that the new pricing structure for workstations may signal an end to market penetration by PCs in the design business.

"We have no pressures to be on the PC at all," says Alberto Jimenez, vice president of Mentor Graphics Corp.'s San Jose Automated Layout Division. Mentor resells workstations from Apollo Computer Inc. Although Mentor will sell PC software to customers, "We actually try our best to discourage them." Mentor's PC offerings were a quick-fix defensive move, Jimenez admits. "At the time, it was the right thing to do. We retained some customers by having it," he says.

"We have no need at all to drive the product down into the DOS world," echoes Joseph Prang, marketing vice president of Valid Logic Systems Inc. in San Jose. The bulk of Valid's software runs on workstations from Digital Equipment Corp. and Sun Microsystems Inc. Valid sells PC software, but it runs under Unix via a coprocessor. Valid's customers design large, complex boards, Prang insists. "Those are tough problems, not the ones you can fit into smaller DOS systems." Also, too many operating systems make for too much effort. "It is a key thing to keep the operating systems and compilers down to a reasonable level," Prang says. "That is one reason why we don't want to screw around with DOS."

General Electric Co.'s Calma subsidiary has long been a CAD player, but mostly for chip design. Calma's senior vice president for electronic design, Bruce Gregory, scoffs at the PC. "Why would I be interested in that? The workstation companies will have overlapped the PC in price in six months if not by the end of the year," he says. "I don't know how you'll be able to tell the difference pretty soon." Calma did sell a customized PC, but now is a reaffirmed believer in Apollo workstations. "We will ride the wave of the workstations," Gregory says. "We're not going to go into the mail-order business — our business is premium software."

"Everyone is interested in CAD/CAE on a personal computer, but at what stage? Design? Verification?" asks Larry Potter, in charge of marketing electronics design systems for Hewlett-Packard Co.'s Fort Collins, Colo., office. HP sells software for its Vectra PC, "but not for much longer," Potter says. That may send a few shivers down Personal CAD Systems' spine, since HP resells P-CAD software. HP's preferred hardware is its own Unix workstation. "I don't think much design automation is going to be done under DOS," Potter says. ☐



Leading suppliers of CAD for printed circuit boards

Note: Around $289 million worth of the CAE market is used to design PCBs.

Source: Prime Data Inc.

stalled base of PCs in engineering situations is roughly about 500,000 units. Apollo and Sun say that they have shipped about 40,000 workstations each. Stone will let IBM solve P-CAD's migration from DOS to Unix through IBM's promised OS/2 and Windows environment, which will eventually allow multiple programs — possibly under multiple operating systems — to show up on one screen.

From the depths

Stone has his own theory about why his rivals are moving up to supply software for the more powerful platforms. "They're afraid of the low-end competition," he says. Stone and his competitors sell through a combination of manufacturer's reps, distributors and direct sales. P-CAD is taking what Stone admits is a risky step by pulling out of the rep chain and setting up a value-added reseller system. Direct sales are expensive, Stone says, demanding the higher gross margins of the pricier workstation software.

Ironically, the PC-based software makers are facing the same pressure from below that they once caused for the CAE workstation companies. The new low-end sharks, including Orcad Systems Corp. of Hillsboro, Ore., sell $500 software packages that users can copy freely. The design software is usually a cut-down — but not by much — version of schematic capture, a sort of high-end drafting tool for making drawings of circuit boards. Sometimes these companies sell through the mail.

"We've got 'em by the short hairs," crows Orcad chairman John Durbetaki. Starting through the mail, Durbetaki claims his company has an installed base of 6,000 units, pretty close to that of the bigger PC companies. "We've broken out of the mold of mail-order software," he says. "Our growth is attributable to our rep organization." Durbetaki says that he has happily picked up some of P-CAD's former reps and saved a lot in training expenses.

Viewlogic's Hanover does admit: "We lose a sale here and there" to the low-cost packages. But, he says, Viewlogic is selling schematic entry in part on the strength of its integration to other applications, including simulation. He denies that low-end pressure forced him onto the bigger hardware. "It expands the market," he says of the low-cost packages, spreading out the availability of design software to more engineers. Once customers try out design automation, he says, they will want more, and appreciate the upgrade path Viewlogic offers.

Downward mobility

Meanwhile, CAD companies that started on minicomputers and workstations are moving some of their software onto PCs. Peter Shaw, president of Calay Systems Inc. in Irvine, Calif., just started selling PC software to integrate with a workstation Calay has been building for years. "Give us time," Shaw says. Likewise, Boulder, Colorado-based Cadnetix Corp. is adding PCs to its homegrown workstation offerings. Vice president O'Neil Feltman says that although Cadnetix has been selling PC software for only eight months, in another few months its installed PC units will outnumber its workstation units two-to-one. Both companies position their workstations as a networked heavy-duty computer for the PC entry seats to share.

Racal-Redac Ltd. of Tewkesbury, England, has been migrating from DEC minicomputers to workstations and PCs for some time. Chief technical officer Richard Barrett says that PC software accounts for 20% of Redac's sales. "We do tend to treat it as a different part of the business," Barrett says. Redac, for instance, does not sell the PC software direct anymore, as it does with its more expensive packages for workstations from Apollo, DEC and Sun. "I'm hard pressed to see how you can do that and do it profitably," he says. "Like any PC product, you can't sell it by knocking on somebody's door. One sales call is still profitable, but by the time you make two calls, you're selling at a loss."

Barrett admits that Redac would rather sell workstation software. "To be quite frank, we're not going to try to sell 50 or 100 of them to Rockwell or Hughes," he says of Redac's software packages for PCs. Now that IBM's latest top of the line personal computer, the as yet undelivered PS/2 80, carries a 32-bit chip, things might be different. "Engineers, will they continue to buy PCs or will they switch to workstations? I don't know," Barrett puzzles. "The top-end PCs and the bottom-end workstations sure as hell don't have a difference in pricing."

And what does IBM think about all this? Well, it does not have any of its board design software running on the PC. Robert Tiel, IBM's director for marketing of electronic design in Valhalla, N.Y., says that IBM is in the process of moving its software onto its Unix workstation, the RT PC. In fact, he admits that the slow pace of that effort is the main reason for the RT's admittedly weak sales. "For the present time, one can anticipate that things put on the RT will show up on the PS/2," Tiel says. ☐

Excellent Companies

Our readers choose the best companies in the electronics industry

By Linda Stallmann and Nancy McSharry

AMP
AT&T
Apple Computer
Avnet
DEC
General Electric
Intel
Raytheon
Seagate Technology
Sun Microsystems

EXCELLENT COMPANIES

COMPONENTS

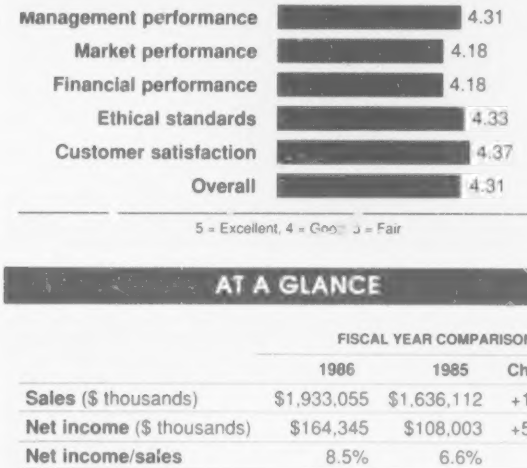
AMP Inc.

Harrisburg, Pa.

NOTABLE ACHIEVEMENTS

- **Opened first plants in Switzerland , South Korea and Taiwan, and second plants in Brazil and Singapore will begin operation in late 1987.**
- **Benefited from strong international currency gains: International sales increased 9% in local currencies – 36% in U.S. dollars.**
- **Created NETCON Division to focus on an active networking/customer premise wiring market.**

STANDARDS OF EXCELLENCE



5 = Excellent, 4 = Good, 3 = Fair

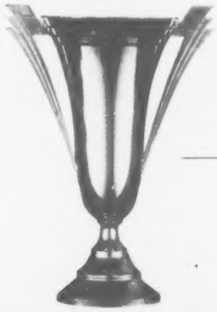
AT A GLANCE

	FISCAL YEAR COMPARISONS		
	1986	1985	Change
Sales ($ thousands)	$1,933,055	$1,636,112	+18.1%
Net income ($ thousands)	$164,345	$108,003	+52.2%
Net income/sales	8.5%	6.6%	—
Cost of sales/sales	56.8%	58.6%	—
R&D/sales	8.8%	9.8%	—
Marketing, G&A/sales	18.7%	19.5%	—
Capital expenditures/sales	7.8%	12.1%	—
Number of employees	21,800	22,800	-4.4%
Sales per employee	$88,672	$71,759	+23.6%
Net income per employee	$7,539	$4,737	+59.1%
Current ratio	1.98	1.86	—
Debt/equity ratio	0.041	0.036	—

Fiscal year ending December 31.

	MOST RECENT SIX MONTHS		
	1987	1986	Change
Sales ($ thousands)	$1,111,724	$945,350	+17.6%
Net income ($ thousands)	$116,650	$75,939	+53.6%

Six months ending June 30.



COMMUNICATIONS

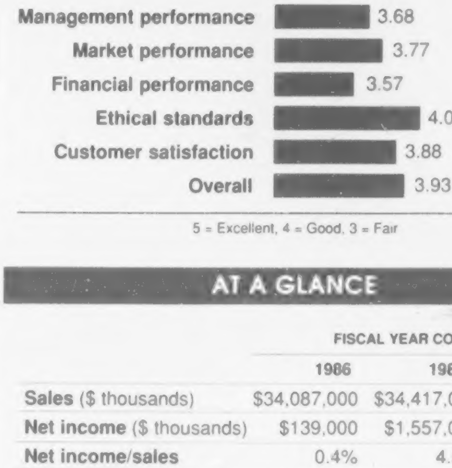
AT&T Co.

New York, N.Y.

NOTABLE ACHIEVEMENTS

- **Long distance revenue remained strong.**
- **Merged various groups into AT&T Federal Systems which now handles all government products and services.**
- **Moved aggressively into international markets; making equity investments and marketing agreements with leading European and Far Eastern companies.**

STANDARDS OF EXCELLENCE



5 = Excellent, 4 = Good, 3 = Fair

AT A GLANCE

	FISCAL YEAR COMPARISONS		
	1986	1985	Change
Sales ($ thousands)	$34,087,000	$34,417,000	-1.0%
Net income ($ thousands)	$139,000	$1,557,000	-91.1%
Net income/sales	0.4%	4.5%	—
Cost of sales/sales	53.5%	52.6%	—
R&D/sales	6.7%	6.5%	—
Marketing, G&A/sales	32.5%	32.3%	—
Capital expenditures/sales	10.6%	12.1%	—
Number of employees	316,900	337,600	-6.1%
Sales per employee	$107,564	$101,946	+5.5%
Net income per employee	$439	$4,612	-90.5%
Current ratio	1.39	1.46	—
Debt/equity ratio	0.51	0.48	—

Fiscal year ending December 31.

	MOST RECENT SIX MONTHS		
	1987	1986	Change
Sales ($ thousands)	$16,522,000	$17,131,000	-3.6%
Net income ($ thousands)	$1,041,000	$776,000	+34.1%

Six months ending June 30.

DESKTOP COMPUTERS

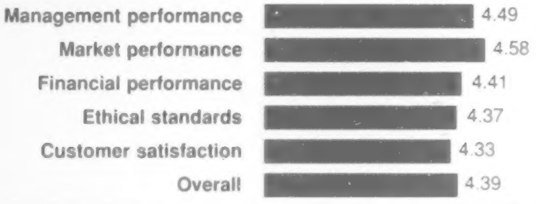
Apple Computer Inc.

Cupertino, Calif.

NOTABLE ACHIEVEMENTS

- **Doubled previous record net income, despite no growth in revenue.**
- **Completed reorganization of company according to function as opposed to product lines.**
- **Increased unit sales of higher-end Macintosh computers and certain peripherals, which offset the effects of reduced sales of lower-end Apple II computers.**

STANDARDS OF EXCELLENCE



5 = Excellent, 4 = Good, 3 = Fair

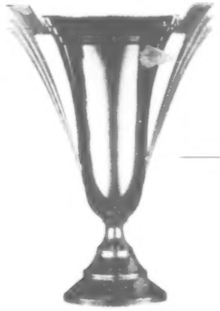
AT A GLANCE

	FISCAL YEAR COMPARISONS		
	1986	**1985**	**Change**
Sales ($ thousands)	$1,901,898	$1,918,280	-0.9%
Net income ($ thousands)	$153,965	$61,223	+151.5%
Net income/sales	8.1%	3.2%	—
Cost of sales/sales	46.9%	58.3%	—
R&D/sales	6.7%	3.8%	—
Marketing, G&A/sales	32.0%	30.7%	—
Capital expenditures/sales	3.5%	2.8%	—
Number of employees	5,600	4,300	+30.2%
Sales per employee	$339,625	$446,112	-23.9%
Net income per employee	$27,493	$14,238	+93.1%
Current ratio	3.17	2.78	—
Debt/equity ratio	No long-term debt		—

Fiscal year ending September 26

	MOST RECENT NINE MONTHS		
	1987	**1986**	**Change**
Sales ($ thousands)	$1,874,644	$1,391,112	+34.8%
Net income ($ thousands)	$145,279	$121,070	+20.0%

Nine months ending June 26.



DISTRIBUTORS

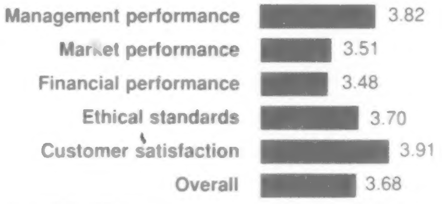
Avnet Inc.

New York, N.Y.

NOTABLE ACHIEVEMENTS

- **Has expanded its relation with Digital Equipment Corp. beyond boards/peripherals to DEC's entire product line (except high-end mainframes).**
- **Entered into new markets such as ASIC design centers and focused more on computer systems.**
- **Formed strategic alliances with a number of companies including N.V. Philips, M/A-COM and Motorola.**

STANDARDS OF EXCELLENCE



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AT A GLANCE

	FISCAL YEAR COMPARISONS		
	1986	**1985**	**Change**
Sales ($ thousands)	$1,426,768	$1,542,441	-7.5%
Net income ($ thousands)	$23,857	$49,384	-51.7%
Net income/sales	1.7%	3.2%	—
Cost of sales/sales	74.6%	72.8%	—
R&D/sales	0.0%	0.0%	—
Marketing, G&A/sales	21.7%	20.4%	—
Capital expenditures/sales	1.6%	2.6%	—
Number of employees	9,250	12,000	-22.9%
Sales per employee	$154,245	$128,537	+20.0%
Net income per employee	$2,579	$4,115	-37.3%
Current ratio	5.17	4.71	—
Debt/equity ratio	0.17	0.18	—

Fiscal year ending June 30.

	MOST RECENT NINE MONTHS		
	1987	**1986**	**Change**
Sales ($ thousands)	$1,117,800	$1,039,700	+7.5%
Net income ($ thousands)	$15,600	$24,100	-35.3%

Nine months ending March 27

COMPUTERS

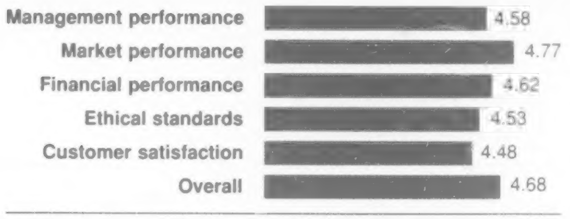
Digital Equipment Corp.

Maynard, Mass.

NOTABLE ACHIEVEMENTS

- Is approaching $10 billion in revenue which brings DEC to about one-fifth the size of IBM, up from about one-seventh two years ago.
- Has successfully sold the concept of networked computers operating in a uniform software environment.
- Made inroads into banking and investment firms that traditionally buy from IBM.

STANDARDS OF EXCELLENCE



5 = Excellent, 4 = Good, 3 = Fair

AT A GLANCE

	FISCAL YEAR COMPARISONS		
	1987	**1986**	**Change**
Sales ($ thousands)	$9,389,444	$7,590,357	+23.7%
Net income ($ thousands)	$1,137,435	$617,420	+84.2%
Net income/sales	12.1%	8.1%	—
Cost of sales/sales	48.1%	56.4%	—
R&D/sales	10.8%	10.7%	—
Marketing, G&A/sales	24.0%	21.9%	—
Capital expenditures/sales	8.0%	7.4%	—
Number of employees	110,500	94,700	+16.7%
Sales per employee	$84,972	$80,152	+6.0%
Net income per employee	$10,294	$6,520	+57.9%
Current ratio	3.40	4.90	—
Debt/equity ratio	0.04	0.06	—

Fiscal year ending June 27

DIVERSIFIED ELECTRONICS

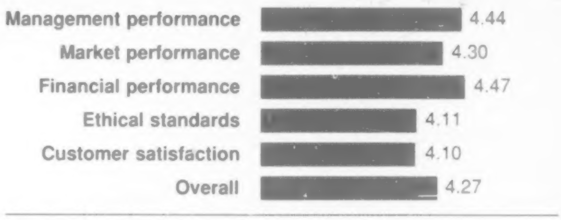
General Electric Co.

Fairfield, Conn.

NOTABLE ACHIEVEMENTS

- In the biggest non-oil merger in history, GE paid $6.4 billion for RCA Corp.
- Sold its consumer electronics business to Thomson SA, and agreed to take over Thomson's medical equipment business.
- In factory automation, GE formed a 50-50 joint venture with Fanuc of Japan, called GE Fanuc Automation Corp.

STANDARDS OF EXCELLENCE



5 = Excellent, 4 = Good, 3 = Fair

AT A GLANCE

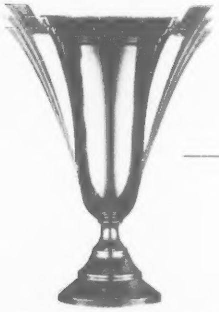
	FISCAL YEAR COMPARISONS		
	1986	**1985**	**Change**
Sales ($ thousands)	$36,725,000	$29,252,000	+25.5%
Net income ($ thousands)	$2,492,000	$2,277,000	+9.4%
Net income/sales	6.8%	7.8%	—
Cost of sales/sales	71.3%	71.3%	—
R&D/sales	3.5%	3.7%	—
Marketing, G&A/sales	16.2%	15.7%	—
Capital expenditures/sales	5.6%	6.7%	—
Number of employees	359,000	292,000	+22.9%
Sales per employee	$102,298	$100,178	+2.1%
Net income per employee	$6,942	$7,798	-11.0%
Current ratio	1.25	1.41	—
Debt/equity ratio	0.29	0.06	—

Fiscal year ending December 31.

	MOST RECENT SIX MONTHS		
	1987	**1986**	**Change**
Sales ($ thousands)	$17,880,000	$13,670,000	+30.8%
Net income ($ thousands)	$1,344,000	$1,158,000	+16.1%

Six months ending June 26.

Information for 1986 includes RCA results from June 1, 1986



SEMICONDUCTORS

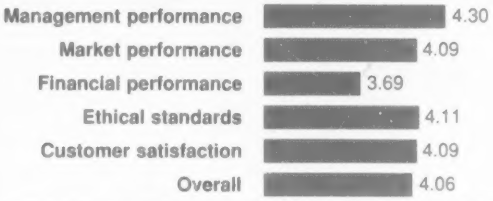
Intel Corp.

Santa Clara, Calif.

NOTABLE ACHIEVEMENTS

- **Spent $228 million for R&D which was 18% of revenue, one of the highest in the industry.**
- **Introduced 74 new products including the 80386, a 32-bit microprocessor which IBM and Compaq are using in their latest PC products.**
- **Moved into the more promising markets such as ASICs, personal computer add-in boards and parallel-processing computers.**

STANDARDS OF EXCELLENCE



5 = Excellent, 4 = Good, 3 = Fair

AT A GLANCE

	FISCAL YEAR COMPARISONS		
	1986	**1985**	**Change**
Sales ($ thousands)	$1,265,011	$1,364,982	-7.3%
Net income ($ thousands)	-$183,284	$1,570	—
Net income/sales	-14.5%	0.1%	—
Cost of sales/sales	68.0%	69.1%	—
R&D/sales	18.0%	14.3%	—
Marketing, G&A/sales	24.6%	21.0%	—
Capital expenditures/sales	12.2%	17.3%	—
Number of employees	18,200	21,300	-14.6%
Sales per employee	$69,506	$64,084	+8.5%
Net income per employee	-$10,071	$74	—
Current ratio	2.73	3.34	—
Debt/equity ratio	0.22	0.19	—

Fiscal year ending December 27.

	MOST RECENT SIX MONTHS		
	1987	**1986**	**Change**
Sales ($ thousands)	$833,489	$585,232	+42.4%
Net income ($ thousands)	$72,004	-$42,533	—

Six months ending June 30.

MILITARY

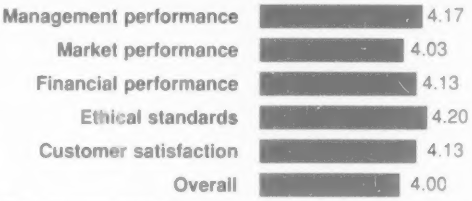
Raytheon Co.

Lexington, Mass.

NOTABLE ACHIEVEMENTS

- **Defense electronics business continues strong: Sales to U.S. government increased 15.9%.**
- **Won two major second-source missile production awards in 1986, bringing the total second-source contracts for missiles programs to four.**
- **Entered into an agreement with Digital Equipment Corp. to produce an advanced family of computers for military use.**

STANDARDS OF EXCELLENCE



5 = Excellent, 4 = Good, 3 = Fair

AT A GLANCE

	FISCAL YEAR COMPARISONS		
	1986	**1985**	**Change**
Sales ($ thousands)	$7,307,952	$6,408,537	+14.0%
Net income ($ thousands)	$393,205	$375,905	+4.6%
Net income/sales	5.4%	5.9%	—
Cost of sales/sales	80.0%	79.1%	—
R&D/sales	3.5%	4.1%	—
Marketing, G&A/sales	9.1%	9.2%	—
Capital expenditures/sales	4.7%	5.3%	—
Number of employees	75,000	73,000	+2.7%
Sales per employee	$97,439	$87,788	+11.0%
Net income per employee	$5,243	$5,149	+1.8%
Current ratio	1.29	1.30	—
Debt/equity ratio	0.02	0.04	—

Fiscal year ending December 31.

	MOST RECENT SIX MONTHS		
	1987	**1986**	**Change**
Sales ($ thousands)	$3,668,000	$3,553,000	+3.2%
Net income ($ thousands)	$212,600	$192,100	+10.7%

Six months ending June 26.

PERIPHERALS

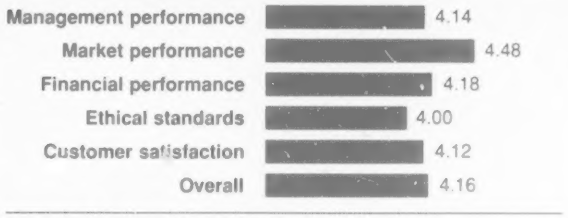
Seagate Technology

Scotts Valley, Calif.

NOTABLE ACHIEVEMENTS

- **Fiscal revenue of $958 million was more than double that of 1986. Profits were four times higher.**
- **Received a contract from IBM to supply two new disk drive models. In 1987 IBM accounted for 24% of sales, down from 26% in 1986 and 49% in 1985.**
- **Signed an agreement with Hewlett-Packard to supply hard disk drives for use in HP's Vectra series computers. Valued at $20 million this year.**

STANDARDS OF EXCELLENCE



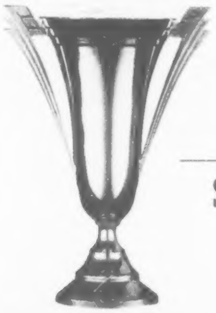
5 = Excellent, 4 = Good, 3 = Fair

AT A GLANCE

	FISCAL YEAR COMPARISONS		
	1987	1986	Change
Sales ($ thousands)	$958,065	$459,836	+108.3%
Net income ($ thousands)	$139,741	$34,536	+304.6%
Net income/sales	14.6%	7.5%	—
Cost of sales/sales	71.5%	80.4%	—
R&D/sales	3.5%	4.1%	—
Marketing, G&A/sales	6.2%	7.0%	—
Capital expenditures/sales	8.7%	8.4%	—
Number of employees	14,932	8,900	+67.8%
Sales per employee	$64,162	$51,667	+24.2%
Net income per employee	$9,358	$3,880	+141.2%
Current ratio	5.95	2.72	—
Debt/equity ratio*	0.85	0.07	—

Fiscal year ending June 30.

* Long-term debt includes convertible subordinated debentures of $287.5 million and other long-term debt and lease obligations of $14.3 million.



CAD/CAM/CAE

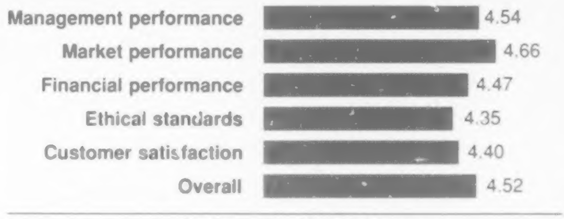
Sun Microsystems Inc.

Mountain View, Calif.

NOTABLE ACHIEVEMENTS

- **Sales rose 156% to $538 million in fiscal 1987.**
- **Introduced a high-end 10 MIPS workstation (incorporating a Fujitsu RISC gate array); at the same time lowering the prices on its low-end workstations to under $5,000.**
- **Began manufacturing in a new 156,000 square foot facility; began expanding worldwide sales and support organizations.**

STANDARDS OF EXCELLENCE



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AT A GLANCE

	FISCAL YEAR COMPARISONS		
	1987	1986	Change
Sales ($ thousands)	$537,537	$210,126	+155.8%
Net income ($ thousands)	$36,298	$11,189	+224.4%
Net income/sales	6.8%	5.3%	—
Cost of sales/sales	50.7%	48.5%	—
R&D/sales	12.9%	14.8%	—
Marketing, G&A/sales	23.6%	27.2%	—
Capital expenditures/sales	0.0%	17.2%	—
Number of employees	3,687	2,031	+81.5%
Sales per employee	$145,793	$103,459	+40.9%
Net income per employee	$9,845	$5,509	+78.7%
Current ratio	2.55	1.98	—
Debt/equity ratio	0.52	0.02	—

Fiscal year ending June 30.

COMMENT

Finding ways to improve Sino-American trade

A leading Chinese government official argues the case for relaxing U.S. export controls on technology

Since China implemented a policy of opening to the outside world in 1979, the nation's electronics industry has imported more than 1,800 items of advanced technology and equipment. These products have played an important role in accelerating the technical development of China's industry and have helped open a vast technical and product market to foreign enterprises.

Following the recent rapid growth of its national economy, China requires even more advanced electronics technology and better-quality electronics products. Hence, the scale of Sino-foreign cooperation in the electronics industry continues to expand.

Since the U.S. government has, in the past few years, taken some positive measures in relaxing its restrictions on technology sales to China, some progress has been made in Sino-U.S. trade and cooperation in the electronics field. But the pace of reducing restrictions on technology transfer to China is still too slow in the Chinese view, and the United States still imposes some restrictions on exports of advanced technology to China.

XIE GAOJUE

John Kilroy

As a result, U.S. electronics companies have lost many potential opportunities to do business with China, even though they produce better products than some other foreign suppliers. For instance, the electronics production capacity of U.S. firms, generally speaking, is much stronger than that of Japan, but, during China's sixth five-year plan period (1981-1985), U.S. companies fulfilled only 20% of China's technology import needs, while Japanese firms supplied 60%. Worse still, in 1986, U.S. firms captured only about 10% of the business, while the Japanese took about 70%.

Unnecessary fears

China understands that some U.S. government officials worry that relaxing restrictions would threaten American national security interests. But such worry is unnecessary. As a developing country, China has a stake

Japan outsells the U.S. in China

Leading U.S. electronics exports to China in 1986

($ millions)

Digital automatic data-processing equipment	$97.171
Professional, scientific and test equipment	$72.980
Machines and parts for the production and assembly of semiconductor devices, diodes, transistors and integrated circuits	$62.987
Central-processing units	$49.085
ICs and other components	$23.249

Sources: U.S. Commerce Department, National Council for U.S.-China Trade

Leading Japanese electronics exports to China in 1986

($ millions)

Telecommunications and sound recording and reproducing equipment	$771.964
Electrical machinery, apparatus and appliances	$589.116
Professional scientific and controlling instruments	$332.548
Office machines and automatic data-processing equipment	$159.616

Source: Chinese government statistics

in a prolonged environment of international peace — in order to build itself into a modern, industrialized nation. Our goal is to quadruple the 1980 gross national output value of industry and agriculture by the year 2000. And that is the reason why, in recent years, China has introduced advanced electronics technology, production equipment, and computer systems from developed countries, to upgrade its existing electronics enterprises, improve its production standards and meet the requirements of its scientific research, education and modern management.

There exists a mutual need to develop Sino-U.S. trade and technical cooperation in the electronics industry

All of these electronics imports play a vital role in raising the technical level of Chinese industry and accelerating the growth of our national economy. China will not infringe upon the safety and interests of any country; on the contrary, China is an important force in the world in maintaining world peace. In fact, a rich, strong and prosperous China will help maintain a peaceful and stable world.

Still, other U.S. government officials worry that China will resell advanced U.S. technology to a third country. The Chinese say that is impossible, because what China imports is only for expanding its own production, not for making money. China hopes to establish long-range, stable, cooperative relationships with all countries, including the United States. This is not an expedient measure. China has imported quite a number of high-tech items from industrialized nations. To protect its foreign partners' economic interests, China strictly protects the foreign partners' technical patent rights according to the contracts signed between them. China has formulated many economic laws, regulations and decrees to protect foreign technology property and will further strengthen these rulings. China abides by contracts and keeps its word. This is recognized by foreign firms the world over.

There exists a mutual need to develop Sino-U.S. trade and technical cooperation in the electronics industry. With the fast development of science and technology, technology is being further renovated; the production and processing of electronics products need more sophisticated technology; and new materials and new products are multiplying. Today, no one country in the world is capable of producing all the goods it needs, or owning all natural resources and all advanced technology. Hence, it is beneficial, to both China and the U.S., to cooperate in the field of electronics on the basis of equality and mutual benefit.

Although the technical level of China's electronics industry has risen over the last few years, it still lags behind that of the developed countries. Our industry's primary task, therefore, is to seek technology, especially advanced high technology, suited to China's basic conditions. This includes: large-scale integrated circuits, telecommunications, computers and software. China will offer preferential terms to foreign firms doing business with China in the field of electronics high technology.

Chinese electronics enterprises and end users prefer U.S.-made technology and products. We are interested in cooperating with both large and small companies. China is willing to adopt such cooperative forms as joint ventures, joint development, coproduction, technology transfer, compensation trade and manufacturing, using supplied materials.

Chinese electronics enterprises and end users prefer U.S.-made technology and products

If the U.S. government carries out a more flexible policy on technology sales to China, Sino-U.S. trade and cooperation in the electronics field will flower in the near future. At present, the international financial market provides a much more favorable climate for the United States to export technology and products. U.S. firms should seize this opportunity.

Xie, vice minister of China's electronics industry, oversees the Ministry of Electronics Industry's program for foreign trade and cooperation. He wrote this article especially for ELECTRONIC BUSINESS

Attention Manufacturing Consultants

ELECTRONIC BUSINESS magazine is preparing a directory of manufacturing consultants. We need your help to make sure the directory is timely and accurate. If you have been employed as a manufacturing consultant to one or more of the ELECTRONIC BUSINESS Top 200 electronic companies (see the July 15, 1987 issue of ELECTRONIC BUSINESS) please send us the following information on company letterhead. The deadline is October 15, 1987.

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Computer Business: IBM takes on DEC with the 9370 PAGE 82

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KEEPING AMERICA
COMPETITIVE

Electronic Business

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BPA ABP

Components and distribution still lead the recovery

There's still plenty of growth ahead, as equipment sales recover. A bonus for N.V. Philips?

The Dutch electronics giant, N.V. Philips' Gloeilampenfabrieken, is currently tendering to increase its ownership of United States-based North American Philips Corp. from 58% to 100%. Although its interest in total ownership may respond to a long-term plan, it has a clear short-term benefit because North American Philips is the largest supplier of nonsemiconductor components in the United States. Thus, N.V. Philips will be able to reap fully the benefits of the current recovery in the market for passive and electromechanical components, as it does currently in the IC market recovery through its 100% ownership of Signetics Corp.

It is clear that chips and other components, as well as the distribution of these components, are leading the recovery. Moreover, the fact that components manufacturers continue to lead the recovery ahead of the business of their major customers — the manufacturers of computers, communications, and other electronic equipment — suggests that there is still plenty of growth ahead. For example, the ELECTRONIC BUSINESS index for revenue, a composite of company revenue from all segments of the electronics industry, grew by only 8% in the second quarter with respect to the same quarter a year earlier. The index's performance was dragged down by IBM, because Big Blue's revenue in that quarter was up a slim 4%.

By contrast, AMP Inc., the largest manufacturer of connectors and interconnection components, saw its sales increase by 19% in the second quarter. Molex Inc., five times smaller than AMP, registered 18% growth. Augat Inc., whose revenue is one-seventh as large as AMP's, went up by 20%. Growth was 21% for capacitor manufacturer AVX Corp., which is a little smaller than Augat.

Chip makers also have seen revenue increase substantially in the second quarter. Intel Corp. racked up a 44% increase, AMD, 25%. Distributors have also participated in the recovery because most of their sales consist of semiconductors and other components. Revenue by the No. 1 industrial distributor, Avnet Inc., advanced 12% in that quarter.

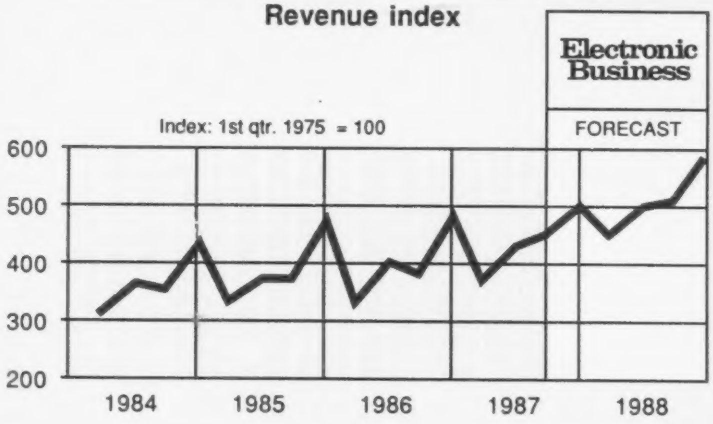
If, as expected, the components manufacturers lead the recovery, they will see more business coming their way as the equipment manufacturers' business starts to recover. Third quarter results have not been released yet, but Cahners Economics forecasts that the revenue index growth will have speeded up to 15% in the third quarter, and that it will end the year with a bang, pushing 1987 revenue 10% higher than 1986's. More significantly, Cahners forecasts that profits will break a two-year decline and be up 26% in 1987.

North American Philips' sales of components, almost all in the United States, may be close to $500 million. At that range, its sales can grow by 20% in the next 12 months. No wonder its Dutch parent wants all of it.

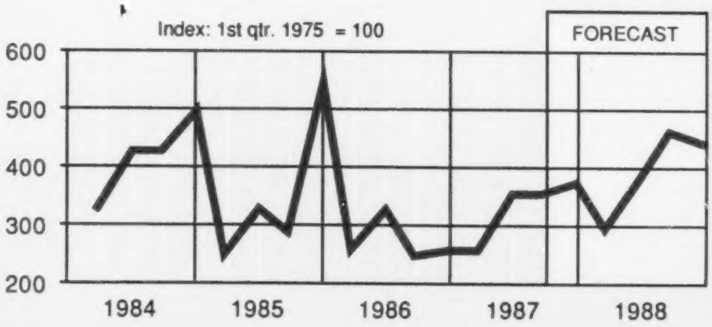
ALBERTO SOCOLOVSKY

Electronic Business indexes

Revenue index

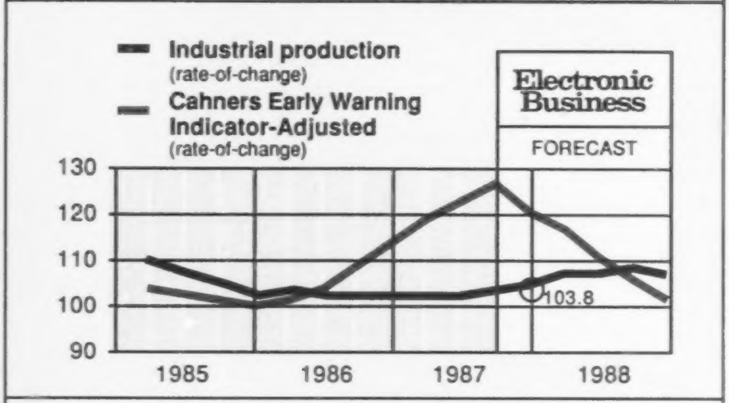


Profit index



Historical data: Dow Jones News/Retrieval; Forecast: Cahners Economics

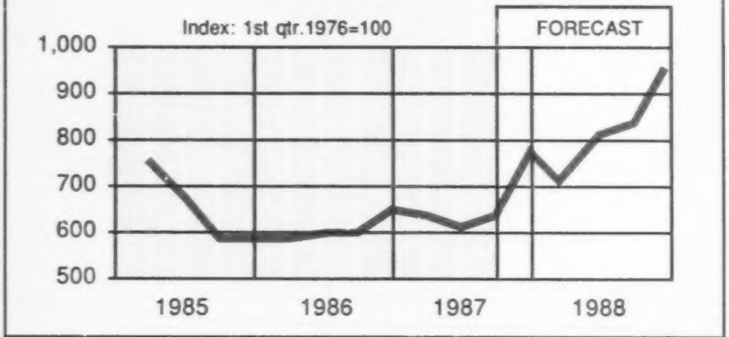
Economic indicators



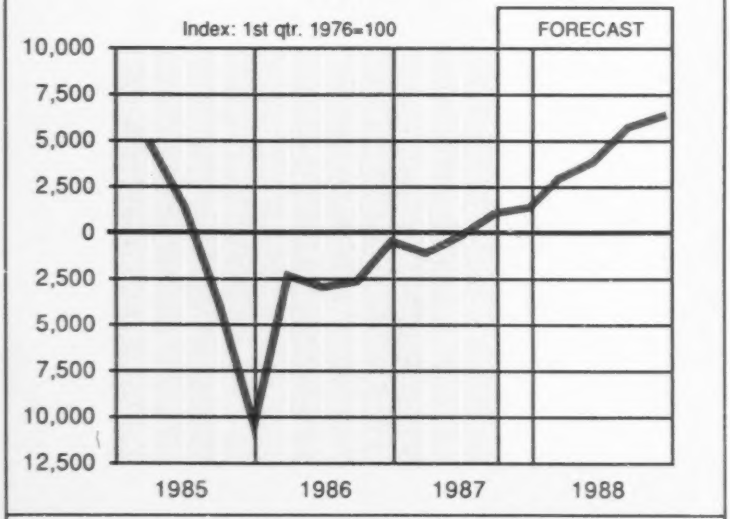
Historical data: Federal Reserve Board; Forecast: Cahners Economics

ATE indexes

Revenue



Profits



Historical data: Dow Jones News/Retrieval; Forecast: Cahners Economics

Steady growth expected
The United States Index of Industrial Production, a coincident indicator of the U.S. economy, has been climbing steadily since the summer of 1986. This spring, output rose 0.7%, according to estimates from the Federal Reserve Board. This slow and steady growth is expected to continue until next summer. Production is expected to rebound after a year and a half of sluggish growth, pushing production up 6.8% in 1988. The impetus for this upturn will be increasing U.S. exports, due to the decline in the value of the dollar; inventory replenishment; and growth in business equipment investment.

A leading indicator, the Cahners Early Warning Indicator (CEWI), is a weighted average of housing starts, the Dow Jones Industrial Stock Index and the money supply (M2) — deflated by the Consumer Price Index. The CEWI has proven to be an excellent forecasting tool. It forecasts the turning points in the economic business cycles about 12 months in advance. Presently, it points to an upturn in the economic business cycle with the next business peak in August of 1988. The black curve is a plot of the 12-month rate-of-change Index of Industrial Production. That is, its change over a 12-month period can be determined by comparison with the line at 100. For example, the 103.8 level forecasts using the CEWI for the end of this year indicates that the average for all of 1987 should be 3.8% above 1986.

The CEWI has been adjusted to compensate for the recent rapid changes in the financial indicators. More information can be obtained from Elizabeth Baatz, economist, Cahners Economics Department, 275 Washington St., Newton, Mass. 02158.

ATE revenue and profit
Although automatic test equipment manufacturers' second quarter revenue fell 4.0% from the prior quarter, it was up 4.2% from the year-ago quarter and increased by 6.2% in the first half of the year from the same period a year ago. Although second quarter revenue was down, demand from computer and semiconductor manufacturers for automatic test equipment shows further signs of strengthening. This year a 10.0% increase is forecast, followed by a sharp 25.8% rise in 1988. ATE manufacturers continued to rack up losses into the first half of 1987. A return to profitability is expected during the second half of the year.

CAE

One niche where Daisy and Valid outpace Mentor

The application-specific hardware market is tiny, but future growth could sizzle. Mentor may miss the boat

Although Mentor Graphics Corp. dominates the overall electronics CAE industry, the company's performance in one important niche has been less than stellar. The market for so-called "application-specific hardware" is controlled by Mentor rivals Daisy Systems Corp. and Valid Logic Systems Inc.

According to Prime Data Inc. of San Jose, Daisy and Valid together controlled about three-quarters of the 1985 and 1986 shipments of hardware built to perform a specific CAE function. This category includes simulation accelerators (hardware engines that speed up the software simulation function) and physical modelers (hardware that enables physical chips to be simulated in conjunction with software).

It is a small but significant victory for Daisy and Valid. The market for application-specific hardware (ASHW) will surge from $80 million this year to $415 million by 1990, according to The Technology Research Group Inc. (TRG), a Boston-based research firm. Even though ASHW will account for just 8% of the total computer-aided engineering market this year, TRG claims that it will account for 16% of CAE in 1990.

"Accelerators will definitely grow faster than the overall market," agrees Robert Moore, vice president for product and industry marketing at Daisy, based in Mountain View, Calif. Adds Larry Potter, a general manager for Hewlett-Packard Co.'s CAE business, "There's a huge market potential for these types of products."

But the trick is figuring out how to tap that potential. So far, the ASHW market has not grown as fast as previously predicted.

High price tags have been the culprit, says David Niehaus, CAE product marketing manager for Cadnetix Corp. of Boulder, Colo. Previously, says Niehaus, "vendors charged as much as the customer could stand." Indeed, the cheapest hardware accelerator cost more than $300,000 several years ago. "These things have to be $20,000 to $30,000," contends Niehaus. Not coincidentally, Cadnetix introduced last June an accelerator with a base price of $31,000.

Another reason for the market's sluggishness has been that customers have had difficulty integrating ASHW with other CAE products. "We need to do a better job of integrating things or the market potential will remain just that, a potential," admits HP's Potter. "The wrong products have been sold," asserts William Loesch, president of start-up Ikos Systems Inc. of Sunnyvale, Calif. Users have had to spend too much time and money integrating these products, says Loesch. "We must provide customers with a solution, not another problem."

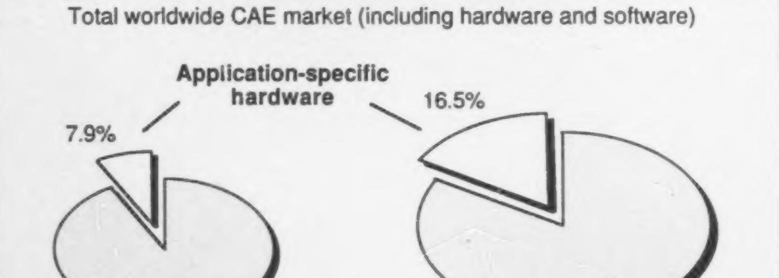
One of the reasons Daisy has been so successful in this niche, says TRG president Andrew S. Rappaport, is because the company has been able to integrate its ASHW better. "On a technical level," says Rappaport, "Daisy's MegaLogician is probably among the worst hardware accelerators ever introduced into the marketplace. However, it didn't make a bit of difference because it was the first working accelerator to be integrated with a popular software simulator." Adds Daisy's Moore: "By only looking at the spec sheets, sure, our accelerator is not as advanced as Zycad's . . . But the real issue is: What does the user get out of it?" Clearly, Daisy's customers get the benefit of seamless integration.

Mentor's customers, on the other hand, reportedly have struggled. Unlike Daisy, which sells a homemade simulation accelerator, Mentor relies on one from Zycad Corp. of St. Paul, Minn. Using the Zycad accelerator with Mentor's products, asserts Rappaport, "has been a real problem."

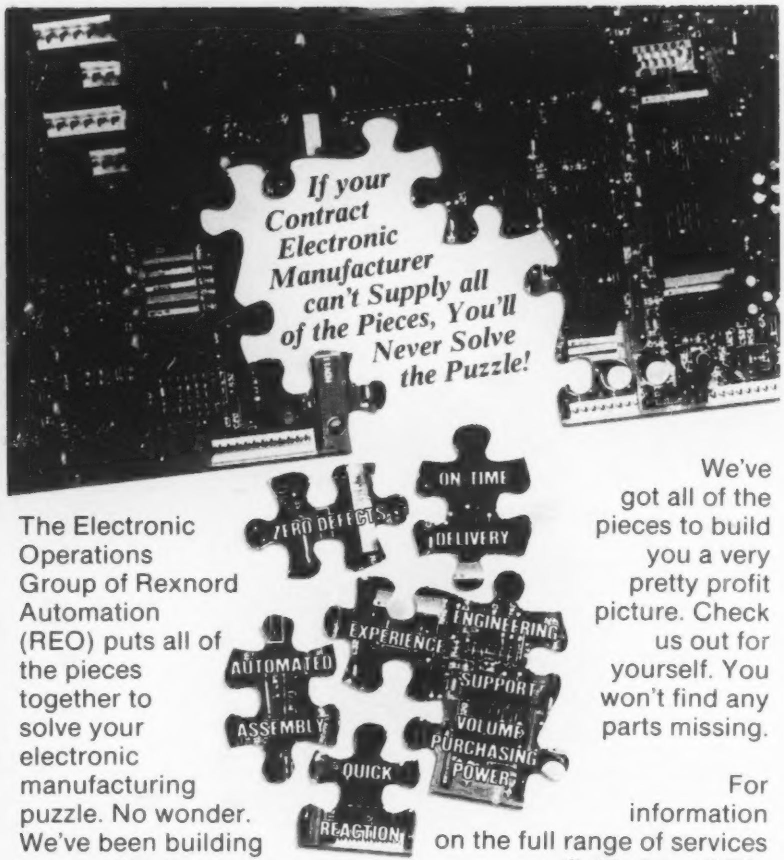
Mentor, headquartered in Beaverton, Ore., does not seem too intent on addressing the problem. According to president Gerard H. Langeler, the company has stopped its R&D work in accelerator technology. This happened after Compute Engine, Mentor's homemade accelerator, all but flopped in the marketplace, according to some outside observers. Langeler says that his company will now depend on outside help for its future accelerators.

Some experts believe that Lange-

The market for application-specific hardware will surge



Source: The Technology Research Group



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ler's strategy is not wise. "Mentor's reluctance to invest in accelerator technology is opening up an enormous opportunity for a company to go in and beat them at the analysis [the raison d'être of CAE] game. Unless Mentor makes a more solid commitment to hardware assistance, you're going to see companies beating them there," asserts the TRG's Rappaport.

Mentor, however, will continue investing R&D resources in physical modeling technology, says Langeler. But Valid, headquartered in San Jose, is striving to derail Mentor's strategy. Last June, Valid initiated a patent violation lawsuit regarding the physical modeling technology. In addition to Mentor, Cadnetix, Daisy, GenRad Inc., HHB Systems and Teradyne Inc. were also named in the suit. Teradyne has since settled out of court. "We think we have a real strong case," asserts W. Douglas Hajjar, Valid president. Not surprisingly, Daisy's Moore disagrees: "We feel that the suit has no merit." Valid aggressively is seeking triple damages in addition to license and royalty fees, according to Hajjar.

Lawsuit notwithstanding, Valid is busy working on a next-generation product. The company recently spun off its physical modeling efforts into a separate company — Logic Modeling Systems Inc. The new venture is privately financed with Valid holding an equity position. Hajjar says that Valid spun off LMSI so that it would not become a resource drain.

Apparently, Valid's efforts in accelerators had become something of a drain. Joseph A. Prang, Valid vice president for product marketing, says that his company, like Mentor, has decided to curtail its R&D work in hardware accelerator technology.

Still, Hajjar counters, "there are a lot of opportunities in application-specific hardware but we just don't have the resources to go chasing after all of them." In addition to accelerators and physical modelers, Mentor's Langeler sees possible opportunities in the computer-aided test area.

CAE vendors are always on the lookout for new opportunities in ASHW because of the plump margins of such products. ASHW helps keep Cadnetix's gross margins high up in the 80% range, says Niehaus. Adds Daisy's Moore, "It's a very profitable business."

ALDEN M. HAYASHI

BY ALBERTO SOCOLOVSKY

Learning to win in a tough global economy

Some American electronics firms are coming back strong in world markets. Cahners magazines will report on their progress

Like the first crocuses of spring, signs of a change in season have begun to brighten the electronics landscape. In reversal of a decade-long erosion of U.S. strength in electronic components and systems, American-built products are making new headway against foreign competition.

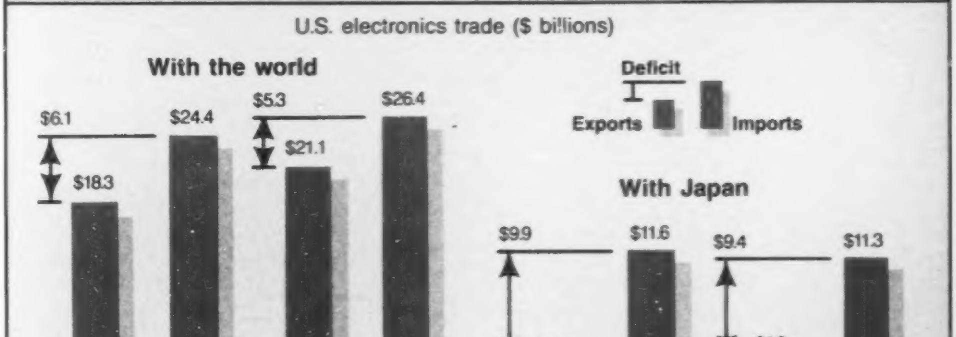
It is happening slowly but steadily, aided by the dear yen, but not entirely dependent on the yen staying expensive. And it is happening in markets that only a few years ago were considered all but lost to foreign imports. Hewlett-Packard Co.'s gas chromatographs, Motorola Inc.'s pagers, Xerox Corp.'s smaller copiers: these are but a few examples. IBM, which fertilized the growth of Pacific Rim electronics industries by externally sourcing close to 95% of the contents of its original Personal Computer, has returned to tending its own gardens. Roughly 60% of the components and assemblies in the new Personal System/2 models have an internal source.

It is not yet clear that the improved competitiveness of America's leadership firms can be matched on a broad basis. Last year's electronics trade deficit with Japan reached an all-time high of $20.4 billion. In office and computing machinery, long an export strength for the United States, the U.S. trade balance has shriveled to less than $1 billion. But there are some signs of broad-based improvement. The American Electronics Association reports that the U.S. worldwide electronics trade deficit shrank from $3.1 billion to $2.6 billion in the first quarter of 1987. Also contracting slightly was the U.S. electronics trade deficit with Japan, down from $5.2 billion to $4.6 billion.

If the base of recovery is to broaden significantly, more U.S. manufacturers will have to take their cues from the top tier of leadership firms. These are the U.S. firms successfully reducing costs, shortening product development cycles, trimming waste, raising yields and steadily, often dramatically, improving the quality and reliability of their products.

Interestingly, all of these firms seem to have come to a clear and early understanding of the same simple competitive reality.

The U.S. electronics trade picture begins to brighten. . .



Source: American Electronics Association

KEEPING AMERICA COMPETITIVE

Innovative design — important as it is — is no longer enough to insure long-term market success. Technology goes only so far in a world where governments subsidize native industries and where intellectual property rights are often scorned. Mastery of the broad spectrum of quality disciplines underlies the revitalization of companies like Hewlett-Packard, IBM and Xerox. In other cases, competitive strength derives from superiority in a single function: the rationalization of scheduling, the mastery of advanced packaging techniques or flawless execution in marketing.

Perhaps most significant is the new emphasis on interdisciplinary teamwork. Cross-pollination between professionals in departments traditionally insulated from each other is helping companies design products that can be more economically sourced, more efficiently produced and more simply tested. Interdisciplinary teamwork between, for example, design and manufacturing engineers, between product planners and key suppliers, insure that problems are solved early — and at minimal cost.

Teamwork is also the theme of Cahners Publishing's Keeping America Competitive series. Because the barriers between departments have blurred; because Cahners electronics publications reach readers in all major corporate functions; and because competitiveness is the single most important issue facing U.S. electronics and systems companies; nine Cahners publications have agreed to jointly address this theme. These nine magazines — Electronic Business, along with Datamation, EDN, EDN News, Electronics Purchasing, Electronic Packaging & Production, Mini Micro Systems, Semiconductor International and Test & Measurement World — have combined circulation of more than 800,000 and last year published more than 11,000 editorial pages. Each magazine will make regular contributions to the series.-

In this first feature, the spotlight falls on Xerox Corp., the target of a decade-long furious Japanese assault on the office products business. Xerox, bloodied but not bowed, has emerged a far stronger and more disciplined company under the forceful leadership of David T. Kearns. ☐

If your company has received an award as a quality supplier, ELECTRONIC BUSINESS would like to know. If your company gives annual awards to its outstanding electronics suppliers, we would be interested in a list of winners. Awards should be for performance in 1986 or 1987.

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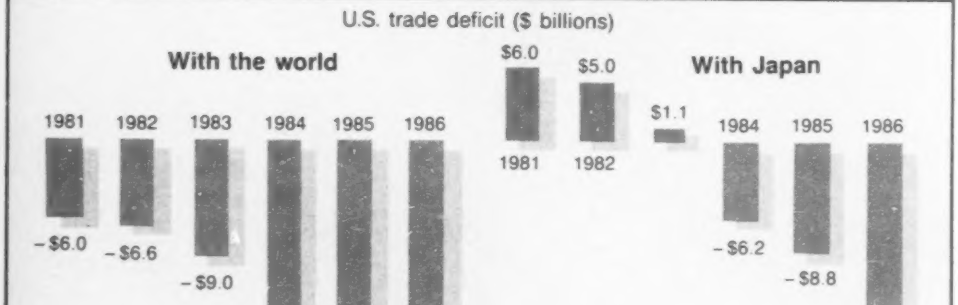


Source: American Electronics Association

MICROPROCESSORS

Move over, Intel-Motorola. Here come the "Others!"

Among the American players in the microprocessor game, application-oriented vendors are making substantial headway

By Valerie Rice

Microprocessors are changing jobs. Once firmly ensconced as the host central-processing unit in a PC or workstation, microprocessors are being forced to find other, more diverse jobs in remote, and perhaps even unheard of, locations.

Not only are they moving around, they are multiplying at phenomenal rates.

And they're changing from the generic, vanilla-flavored product that did almost anything, to a new application-specific microprocessor that is tweaked and focused to do a particular job. For the first time, "a microprocessor does not have to solve all the problems," Integrated Circuit Engineering Corp. market research manager William J. McLean says.

The reason, of course, is competition. For many customers, there are only two microprocessor companies: Intel Corp. and Motorola Inc. "Motorola and Intel are clearly the winners," stresses Altos Computer Systems Inc.'s vice president Jeff Bork. "Demand is clearly behind the winners."

But for U.S. semiconductor manufacturers wanting to play in the microprocessor world — and there are a number of them, many with 32-bit offerings — opportunities would appear to be limited.

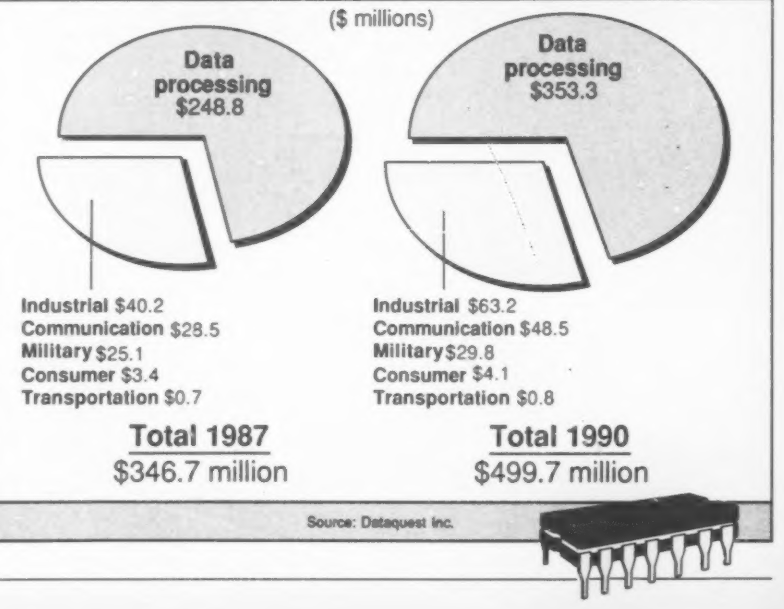
Among U.S. players in the market (excluding six of the top 10 microprocessor manufacturers, all of which are Japanese), Intel will have 44% of the 1987 dollar market share for 32-bit microprocessors; Motorola will have 40%; and the "Others" — including Advanced Micro Devices Inc., Harris Corp. and National Semiconductor Corp. with its newly proposed acquisition, Fairchild Semiconductor Corp. — will have the rest. That's out of a market that's only about $375 million, according to ICE. Also, the Scottsdale, Arizona research firm forecasts that the share of market in the 32-bit arena will change in 1991 to Intel and Motorola with 35% and 33%, respectively, while the "Others" will increase to 32%. The total market in 1991 is predicted to be $1.3 billion.

Additionally, 50% of 32-bit microprocessors are going into the office automation market this year, according to ICE, with 40% going into workstations, and the remaining 10% making up the "other" category. The two largest applications, PCs and workstations, are the areas where Intel and Motorola are leaders.

Obviously, general-purpose microprocessors will continue to dominate the market, at least in the areas of personal computers and workstations. Companies directly challenging the dominance of Intel, Motorola and National will be hard pressed to make an impact on the market, McLean says. "Who else besides these three are going to be major players?" McLean asks. AMD, which claims to be challenging Intel and Motorola in "their next generation" will be unable to take their place, McLean predicts.

And some customers agree. Altos' Bork says that his company is a com-

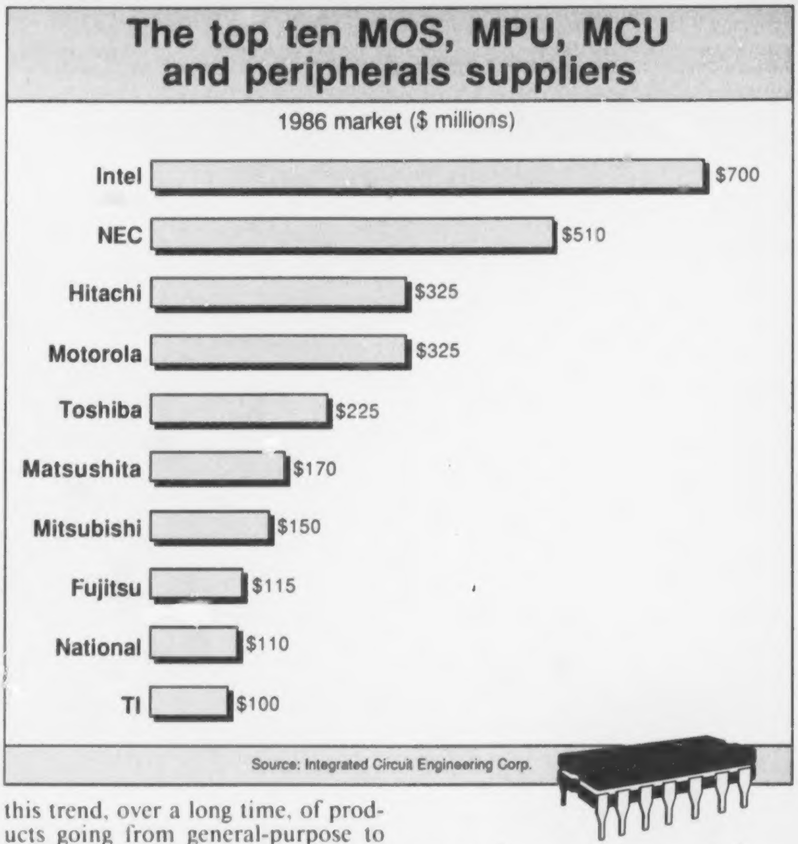
U.S. consumption of microprocessors



Source: Dataquest Inc.

mitted "Intel house" despite the fact that the company offers Motorola's 68020 in its OEM channel. The high level of acceptance and recognition that Intel products have in the market will keep Altos a long-term customer, Bork says. "The most important thing is compatibility," Bork says. "We have a huge base of software (XENIX System V) that we have to remain compatible with. I don't see a place for three microprocessors. You can put a chip on that may be more powerful, but for our multiuser systems, throughput is more important than pure power."

That is not to say, however, that there aren't market opportunities for other, more focused microprocessors today in the United States. But the opportunities are less obvious than PCs or workstations and often require some redefining on the part of both the engineer and the marketer. And, as McLean cautions, even in 1991, the market for non-PC or workstation applications is only going to be 25% of the total. But for companies looking for a steady revenue stream, and not for a "save the company" strategy, plenty of money can be made in microprocessor niche markets.


The top ten MOS, MPU, MCU and peripherals suppliers

Source: Integrated Circuit Engineering Corp.

Host or no-host

Distributed processing, where computing moves from a central location or chip (like the host CPU of old) to a more decentralized, job-sharing environment, is made for application-specific microprocessors.

According to Dataquest Inc.'s industry analyst Alice Leeper, the number of microprocessors in a personal computer has grown dramatically in the last five years. In 1982, a PC had two microprocessors, one for the central processing unit and one for the keyboard. In 1987, an average PC has between five and six microprocessors, one each — typically — for the machine's CPU, keyboard, display and/or graphics, the I/O disk, and the math coprocessor. Some 32-bit systems even have cache memory controllers, Leeper says.

This growth in the number of microprocessors, coupled with user demands for more complex central processors, as well as more speed and less space, has created a market where peripheral chips can step in to offload some of the duties once assigned to a host CPU.

Texas Instruments Inc. is banking on this trend, says marketing manager Jim Huffhines. "We have seen this trend, over a long time, of products going from general-purpose to user-specific, and in between these two extremes there is application specific. We are focused on the application-specific class of microprocessor."

TI's strategy is to compete by coexisting. Huffhines says that the company concedes the installed base of Intel and Motorola products and software, and is willing to take the peripheral functions left undone by those host processors. TI is aggressively pursuing microprocessor slots for digital signal processing (DSP) with its TMS 320 family; local area network applications processing; graphics with the 34010; and speech synthesis and recognition.

Embedded controllers are sort of the unsung heroes of the microprocessor arena

The dilemma facing TI's customers, Huffhines says, is how to continue to increase performance and remain competitive, while preserving the software base. "You can only shrink geometries so much," Huffhines says. "We see everyday customers adding to their box to improve performance because their customer wants them to improve performance." With dedicated microprocessor chips that concentrate solely on one area of a system's performance, overall performance can improve dramatically, Huffhines says. Volume is the other advantage to TI's strategy, he continues. "We'll have more processors in a PC than Intel has."

At Fairchild Semiconductor, which National agreed to purchase last month for $122 million in securities, coexistence is also the name of the game. Like TI, Fairchild "will very generously keep the things that drive the keyboard and the displays," says Stav Prodromou, executive vice president and general manager of the custom and microprocessor unit. "Those are very high volume things, and we want to keep them," he says.

Ironically, however, Fairchild's major customer, Intergraph Corp., uses an Intel 80386 as an I/O processor, while the Clipper is used as the system engine.

Low-profile markets

Embedded controllers are sort of the unsung heroes of the microprocessor arena. The embedded controller market encompasses a number of fast growing areas including laser printers, robotics, avionics, disk subsystems and process control — all attractive segments to market players, old and new.

One company that has staked out its claim in the embedded control market is National. It is certainly not the only player in the market, however, and others, such as AMD, Intel, Motorola and TI are all after a piece of the action.

Intel's 386 marketing manager Claude Leglise says that although the trend toward 32-bit embedded controllers has gone fairly slowly at Intel due to the preponderance of 8- and 16-bit solutions, he feels that by 1990 the trend will pick up dramatically. "Eighty percent of our business is driven by software," Leglise says. "The reusability of software is really the issue. You put it in the box and close the lid. With the embedded stuff, software is not part of the equation. That leaves lots of room for lots of different options."

National, with its 32532, is well-positioned to "have a shot at it," Dataquest's Leeper says. According to 32000 product marketing manager Anne Wagner, the company's primary target is laser printers, where "we expect to dominate," she says.

The reason that National has embarked on its peripherals strategy, Wagner says, is because of the great demand in the PC market, which has fueled the need for faster and higher performance peripherals. There is also high volume in peripherals.

Probably National's biggest ace in the printer market is its recent deal with Canon Inc.'s office automation division, which is responsible for an entire line of office products from facsimile machines to systems and of course, laser printers. The deal with Canon, described as a joint technology development agreement, has National supplying the 532, and other parts from its 32000 line, to Canon, which will in turn incorporate those chips into future products. Motorola, which has sold its 68000 line to Canon in the past, will continue to do so, says Jeff Nutt, a Motorola marketing manager. And he does not see a downturn in sales as a result of the National agreement.

This relationship with Canon, which market research firm InfoCorp estimates has 97% of the laser printer market, should help establish National firmly in this market, analysts believe. Dataquest's Leeper says that any time a company has a relationship with the No. 1 or 2 supplier in a market, it is bound to be a relatively high volume success.

However, competition in the embedded controller market is heating up. Intel now has an Embedded Controller Group, TI is in the market with its DSP products, and AMD has said publicly that it plans to position its new 29000 in several of these markets, including laser printers. Motorola's customer list for the 68020 line includes over a dozen companies with embedded controller products, and Motorola says that percentage of its market is increasing. Just in telephone switching alone, Motorola's Nutt says, customer Northern Telecom can use 1,400 of the 68020 per system, and in some cases, it could use as many as 5,000.

AMD, probably the most difficult to judge because they are not shipping product, may also have the toughest time of it, analysts say. AMD, which wants one-third of its business in host processors and the rest in embedded-type applications, will likely do well at the "Corvette" level of host product — very high end and high average selling price, and relatively low volume, one analyst says. However, they are probably well-positioned in parts of the embedded market where software freedom can make the choices much easier.

The military market will consume $25.1 million worth of microprocessors by 1987

Other markets

In addition to embedded control and peripheral chips, microprocessors are increasingly going into other markets.

At Fairchild, for example, officials claim that the Clipper has had a high degree of acceptance in the military, and the company plans to release a military version of the chip in the near future. According to company executives, sales of the Clipper to the military in the future could account for as much as one-third of revenue, but only taking up 10% of the volume. Dataquest estimates that the military market will consume $25.1 million worth of microprocessors in 1987, up from $17.2 million in 1986. That figure will grow to $29.8 million in 1990.

Telecommunications is also growing, and is a major area for a number of players including Fairchild's new parent, National, and Motorola. Telecommunications, which is forecast to consume $28.5 million microprocessors in 1987, will jump dramatically to $48.5 million by 1990, Dataquest says. Those numbers dovetail with TI's view of the market, which reflects some slowness in acceptance of local area networks, Huffhines says. However, IBM's Token Ring LAN, in which TI has participated, is gaining market share, Huffhines says, and so the outlook for telecommunications looks bright.

For Motorola and others, the consumer segment of the market is holding up well — with toys, optical disks, cameras and other equipment showing increasing numbers of chips per part. Dataquest is only forecasting moderate growth in this area, however, from $3.4 million in microprocessors consumed in 1987, to $4.1 million, by 1990.

Inmos Corp., Colorado Springs, which makes the Transputer, has had to wait several years since the product's introduction in 1985 to see some non-board-level applications. Recently, however, the company has two brand new applications to boast of; a picture phone, developed by a Japanese company, that transmits a still picture across a phone line every eight seconds; and a computer for analyzing fingerprints.

Dataquest's Mel Thomsen, in talking about the Transputer, says that these new applications take advantage of what the processor does best: imaging processing. "There isn't enough business out there to support all those microprocessors," he says, so companies need to do what Inmos has done and "break down the problems into little pieces to be solved" by individual processors. This strategy allows the development of products never done before.

And, occasionally, fairy tales do happen. Take, for example, Fairchild, which now sells its Clipper to Intergraph for use in that company's new workstations. In a portion of the business, Fairchild supplanted its new owner, National, which still sells the 32032 to Intergraph for its older line, but is not represented in its new machines. Intergraph's sales support workstation marketing manager Gene Grindstaff says that Intergraph had reached a point where it was looking around for the next step in functionality and performance in workstations, and the Clipper's 5 MIPS performance was impressive to the company. "The Clipper has a lot of growth potential," Grindstaff says. ☐

CONTRACT ASSEMBLY

Only those with deep pockets need apply

Launching an SMT contract manufacturing business can be profitable, but it's not always as easy as it seems

By Carol Suby

Contract manufacturers offering surface mount technology (SMT) report that business is proceeding at a rapid clip, thanks in large part to a return to normalcy in the computer industry.

The value of surface-mount contract work being performed in the United States should reach $260 million by the end of this year, and is forecast to hit $1.24 billion by the end of 1992, reflecting an average annual growth rate of 62.8%, according to research firm Dataquest Inc. in San Jose.

The data-processing segment of the industry is currently fueling this fire and accounts for 44% of surface mount work being performed by assembly contractors, according to Dataquest. For example, over the past 18 months Interplex Technologies Corp. (ITC), the surface mount division of Interplex Industries Corp., received approximately 7,000 inquiries, although only 300 turned into orders. According to Walter Bailey, vice president of this Hackensack, New Jersey-based company, most of Interplex's surface mount business is coming mainly from major computer companies —and the same is true, he says, of other contract assemblers.

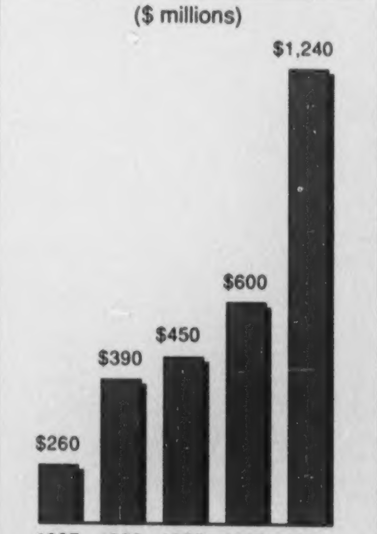
Far behind data processing in the No. 2 spot is communications, which accounts for 17%, followed by military at 14%, industrial at 10% and consumer at 8%.

And because the technology — which involves placing components directly onto a printed circuit board rather than by inserting leaded devices — allows manufacturers to fit more devices into the same space, demand by customers is accelerating.

At Universal's Specialized Electronics Products division (SEP), in Binghamton, N.Y., for example, surface mount revenue is spiraling from 10% of last year's sales, to 30% this year, and could climb as high as 40% during 1988, according to Ronald Budacz, vice president of this division. He estimates his contract manufacturing operation is currently placing approximately 1 million surface mount components per day.

SEP's overall success in the contract manufacturing business has been strong enough, in fact, to warrant spinning off this contract manufacturing arm of Universal into a separate company. As of Dec. 31, 1987, SEP will be formed into Dover Electronics Manufacturing Inc., and become a member company of Dover Technologies International Group, a subsidiary of Dover Corp.

SMT revenue of contract manufacturers



Average annual growth rate = 62.8%

Source: Dataquest Inc.

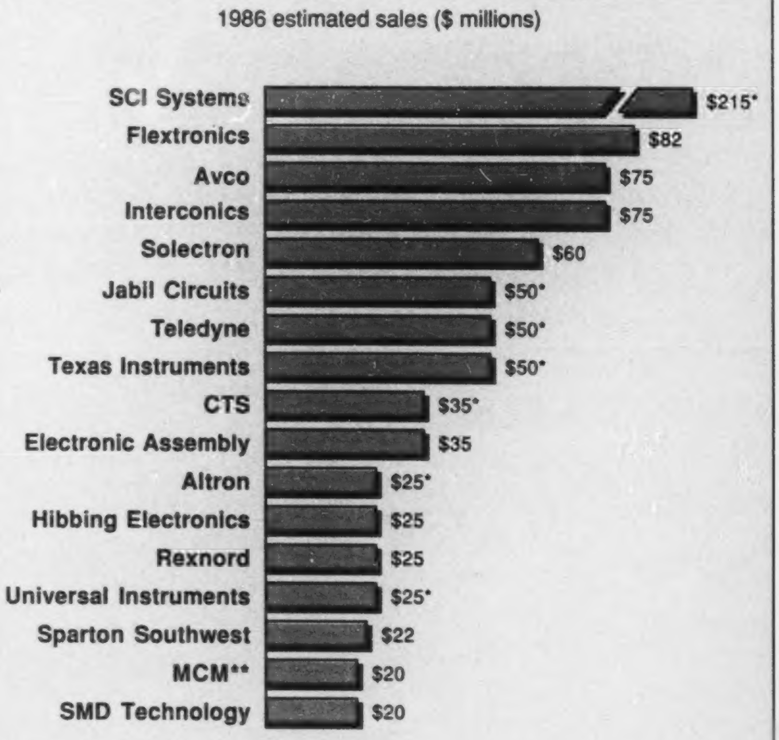
Not for everyone

Despite the attractive growth figures, subcontracting surface mount jobs is not for everyone. Not only is it very capital intensive, it also takes quite a long time to get over the learning curve, says Roger Main, president of IEC Electronics Corp., a privately held contract manufacturer whose 1986 revenue was approximately $16 million. As early as the 1970s, this Newark, New York-based company was producing boards with surface mount components. But, about 18 months ago, IEC had to scrap all of its surface mount equipment and spend $3.5 million to replace it, says Main, who has just ordered even more equipment, to the tune of approximately $750,000.

Indeed, putting together a high-speed surface mount production line — an average of 3 million components placed per month — can cost as much as $800,000 to $1 million, and yet the equipment obsoletes very quickly. So says Winston Chen, president of San Jose-based Solectron Corp. Also, the manufacturing process of SMT — which involves high densities, tight tolerances and a difficult soldering process — is five to 10 times harder to execute than through-hole technology. "In addition, "there is a shortage of talent and expertise" to make the production process a reality, says Chen.

Even when a company is willing to make the commitment, serious problems can occur. In 1985, NCR Corp. began operating a surface-mount assembly line for its Tower family of supermicro computers at its engineering and manufacturing facility in Columbia, S.C. After investing a "sizable amount" in surface-mount production equipment, and then be-

Top U.S. contract PCB assemblers



* Sales figure is an estimate based on the number of employees and the number of boards assembled each year compared with industry ratios.

** MCM is now a wholly owned subsidiary of Flextronics

Source: Gnostic Concepts Inc.

ing left with excess capacity, the company initially decided to "really go after" the contract business, says John Schafer, manufacturing coordinator. However, "as we got into it, we ran into some test problems," Schafer says. For now, NCR hasn't contracted with any outside clients, but hopes to do so once the test problems are resolved.

For these reasons, the major players in the sport of surface-mount contract assembly are deep-pocketed, multimillion dollar firms whose full line of services — referred to as "turnkey" — extend from helping a customer with board designs and product prototypes, to performing component procurement, assembly, test and packaging.

Avco Electronics/Textron, with an estimated $75 million in revenue last year, has more than six design engineers working on surface mount projects, and is currently adding to that staff, according to James Welchly, director for marketing at the Huntsville, Alabama-based company.

Flextronics Inc., the second largest U.S. contract manufacturer with 1986 revenue estimated at $82 million, has more than 20 members of an engineering group involved in all facets of SMT, according to company president Robert Todd. In addition to an extensive engineering staff, the Newark, California-based company has more than $3 million invested in surface-mount capital equipment and offers turnkey services from design and procurement to building a complete product in a box. Even though many of the larger contract manufacturers have developed their staffs in house, Flextronics has added a number of capabilities and extended certain services via acquisitions. This year alone, Flextronics has purchased three companies: JTE Graphics, a designer of PCB layouts for surface mount devices; and MCM Industries and Vortech Corp., two independent test houses.

Enter the OEMs

Another group of companies with substantial financial resources, large production facilities, worldwide purchasing power and a great deal of surface mount expertise is also jumping into the foray of surface-mount contract manufacturing. These are the original equipment manufacturers (OEMs).

When Kodak Apparatus Division (KAD) — the manufacturing arm of optoelectronics firm Eastman Kodak Co. — was formed during the last quarter of 1984, a decision was made to take in subcontract work from outside customers. Of the more than 50 external clients KAD is currently servicing, 10 of those are for electronic assemblies and eight of those involve SMT.

Texas Instruments is taking in surface mount work at three locations. Its Data Systems Group in Austin, Texas, manufactures boards with surface mount components for other TI divisions, as well as for outside clients. The Industrial Systems Division, in Johnson City, Tenn., has more than five outside clients for surface-mount assembly work, and that number is growing rapidly, according to Charles Starks, contract manufacturing manager.

Starks reports that the division is currently exceeding capacity and is buying more production equipment to enable the facility to meet its surface mount demand. TI's Semiconductor Group in Houston helps customers design memory boards that contain surface mount components. However, this represents far less than 5% of the Group's total custom-related business, says Robert Harrison, general manager of the Houston facility.

Xerox Corp. first offered third-party or subcontract services at its Wellingard City facility in Britain. Today, the company is trying to repeat its European success at its El Segundo, Calif., facility. So far, one "large customer" has been signed on and two more are in the process of signing up, according to Brian Weyman, vice president for manufacturing in Southern California.

Despite such an interest on the part of OEMs, money does not seem to be the primary motivating factor. Pretax profit margins in this business can run between 5% and 15%, according to Pamela Gordon, president of research firm Technology Forecasters in Berkeley, Calif. And, few OEMs put profit at the top of their lists when justifying their reasons for being in the subcontract business. In listing KAD's rationale for taking on external clients, Kevin Moriarty, customer account manager at Kodak's KAD, maintains that foremost, Kodak wanted to fully utilize its plant. In addition, the company felt that by keeping in touch with outside clients, Kodak would stay technologically astute and would benefit by operating in a competitive environment.

But "there are limits to the extent of market share they [OEMs] will gain," cautions Charles-Henri Mangin, president of consulting firm Ceeris International Inc. in Old Lyme, Conn. Although a number of large equipment manufacturers have experience in surface mount technologies, Mangin says, "the big guys have difficulty competing with subcontractors." One factor is wages, which average between $25 to $50 per hour at OEM locations, but are closer to $12 to $20 at subcontractor locations. In addition, traditional contract manufacturers offer customers more flexibility and customers can better bargain with companies dedicated to servicing outside clients, Mangin suggests. Nevertheless, those who want a risk-free approach for assembly and want the insurance of a big name are attracted to the big manufacturers.

Although the days of the mom-and-pop garage operations are numbered due to the complexities of SMT, opportunities remain for small to midsized firms. Started up in mid-1985, Interconnect Technology Inc., for example, specializes in the manufacture of boards that contain 100% surface mount components. The Beaverton, Oregon-based company — which claims it has capacity to place 1 million components per month — also holds a patent for a laser beam process for routing circuitry through various layers of a printed circuit board. This patent, insists Allen Peecher, vice president for manufacturing, has helped Interconnect attract more than 30 customers, including Digital Equipment Corp., Hewlett-Packard Co., Intel Corp. and Tektronix Inc. ☐

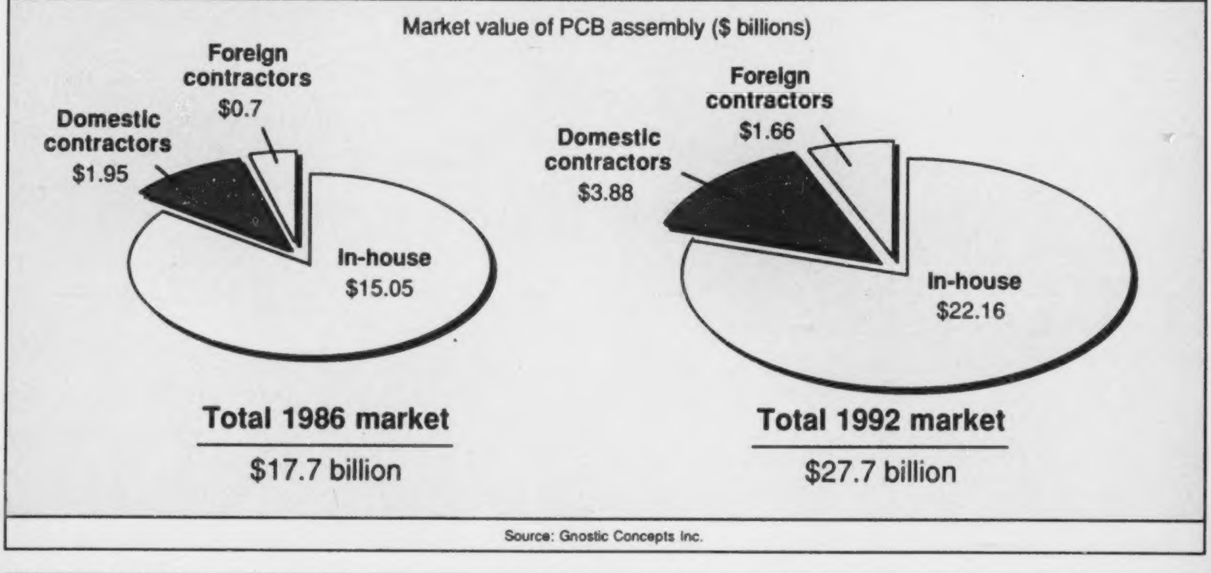
Contract manufacturing abroad

Because domestic contract manufacturers are servicing many customers that have a worldwide presence, opening facilities in Europe and the Far East seems like a natural business progression. Flextronics Inc. and the No. 1 U.S. contract manufacturer, SCI Systems Inc., are among the only major domestic players to currently offer offshore manufacturing, but others, including Universal/Dover's Specialized Electronics Products, are looking into such expansions. How important offshore capabilities will be in the future of surface mount manufacturing remains to be seen. But, for now, the trend in SMT manufacturing is to bring business back onto U.S. soil. [ELECTRONIC BUSINESS, April 1, 1987, p24]

Indeed, contract manufacturing of SMT "will be a lucrative market in the good ol' U.S.A. for those contract manufacturers who want to stay here," says Ronald Budacz of Universal/Dover's SEP. Although Budacz believes that companies will not have to leave the United States as a prerequisite for survival, he is currently investigating the possibility of opening a manufacturing facility in the Far East.

Across the Atlantic, contract assembly work is also catching on in Scotland where a number of OEMs — such as Highland Electronics Ltd. and Timex Corp. — are winning contracts from the myriad electronics companies that have facilities in Britain. In addition, there are a number of dedicated contract assemblers — such as Keltek Electronics Ltd. — that are beginning to tread in SMT waters. ☐

Domestic contractors gain share in PCB assembly solutions



Source: Gnostic Concepts Inc.

JAPAN

The new bottom line in Japanese electronics

Some Japanese firms are doing surprisingly well, even though the high yen has played havoc with their margins

By Paula Doe

The high yen devastates Japanese margins

Composite 1986 performance:
Japanese versus U.S. electronics companies

	Japanese top 20	U.S. top 20	U.S. top 200
Electronics revenue ($ billions)	$137.3	$174.4	$279.2
Change from 1985	+2.6%	+4.7%	+4.3%
Total revenue ($ billions)	$221.1	$252.0	$641.7
Change from 1985	-1.9%	-20.5%	-19.6%
Net income ($ billions)	$4.3	$13.2	$26.7
Change from 1985	-38.8%	-25.8%	-24.6%
Net income/sales	2%	5%	4%
Return on equity	4.3%	10.8%	10.2%
Revenue per employee	$164,400	$89,000	$102,300
Change from 1985	-23%	+2%	-8%
Net income per employee	$3,100	$4,000	$4,300
Change from 1985	-47%	-11%	-14%
Exports or foreign sales/total sales[1]			
1986	40%	46%	25%
1985	46%	27%	14%

Japanese percentage change figures are based on yen values.

[1] Japanese figures are parent company exports only, and thus include the parent's sales to its overseas subsidiaries for resale abroad, but not overseas production by the subsidiary. The U.S. figures, however, include both exports and overseas production.

1985 figures are as originally reported last year using ¥180 = $1.

Source: ELECTRONIC BUSINESS

It was a terrible year for Japan's electronics sector overall. Earnings plummeted an average of 39% at the top 20 companies for fiscal 1986, which ended in March 1987 for most companies. But given the 19% appreciation of the yen against the dollar during the year, on top of a 27% rise the year before, it's a wonder the sector did as well as it did in the drastically altered competitive environment. Some companies even did surprisingly well.

ELECTRONIC BUSINESS compiles the latest available consolidated financial information from the major Japanese electronics companies from published Japanese materials and from the companies themselves, long before most of the companies publish their English language annual reports. We figure electronics revenue for these companies by the same standards we use for our annual listing of the ELECTRONIC BUSINESS 200. James Capel Securities Inc. helped us gather some of the latest figures this year.

Margins for the sector as a whole were miserable by every measure. Operating margins were squeezed to a mere 5 cents for each dollar of sales, on average, down even from last year's meager 7 cents. That was an average drop of 38%. Some individual companies fared far worse. Sanyo Electric Company Ltd. saw an 89% drop in operating income and Sony Corp., 75%. Alps Electric Company Ltd. and Sanyo had operating margins of a mere 1%.

The 39% average drop in net income meant average net margins slipped to 2% of sales, down even from last year's slim 3%. The roster of big names earning only 1% on their multibillion-dollar consolidated worldwide sales includes Alps, Canon Inc., Citizen Watch Company Ltd., Fujitsu Ltd., Mitsubishi Electric Corp., NEC Corp., Omron Tateisi Electronics Co. and Toshiba Corp.

The top Japanese companies earned only 4% on their shareholders' equity, compared with 11% for the top 20 U.S. companies. Return on total investment will be significantly lower still, probably around 2%, given the high levels of debt usually carried by the Japanese companies, but reliable figures were not yet available.

Still, it's a wonder these results aren't worse, given the dismal conditions these Japanese companies had to cope with. Japanese earnings were down 39%, and earnings of the top U.S. companies were down 26% themselves, despite the advantage of the cheap dollar. And although Japanese margins were slimmer than usual, none of the major companies lost money.

Even the few companies that finished last year in the red, like Oki and Pioneer Electronic Corp., managed to slash costs, move away from exports and move up to higher value-added products to make a little money this year. And despite the adverse environment, companies selling such unglamorous and supposedly low-margin products as components and consumer electronics managed to net 4% to 6% of sales, matching the 5% average of the top 20 U.S. electronics companies. Matsushita Electric Industrial Company Ltd. maintained operating margins of 7% and netted 4%, TDK Electronics Company Ltd. netted 4% on an operating margin of 10%, and Kyocera netted 6% on operating margins of 12%.

Reshaping the industry

As the high yen forces individual companies to restructure, it is also reshaping the industry as a whole. Many of the old generalizations that used to be drawn about the Japanese electronics industry aren't so true anymore.

For one thing, the new world order of 140 yen to ¥150 to the dollar is devastating that legendary Japanese productivity. Falling prices, slumping sales, excess capacity, excess domestic employees as production is shifted overseas, cutbacks in capital investment, the shift to making new and more complex higher value-added products — whatever the reasons, the top Japanese companies' revenue per employee slid 23% for the year, on top of roughly a 33% drop the year before. That brings the Japanese figure down to 1.85 times that for the top 20 U.S. companies, and only 1.6 times that for the ELECTRONIC BUSINESS 200, instead of 2 times to 3 times the U.S. level as it has been in some past years.

> The new world order of ¥140 to ¥150 to the dollar is devastating that legendary Japanese productivity

The top U.S. companies surpassed their Japanese rivals in earnings per employee this year, as the Japanese net income per worker fell 47%, to $3,100. That was only 78% of the U.S. level. The top 20 U.S. electronics companies netted $4,000 per employee, and the top 200, $4,300. Last year net income per employee in the two countries was about equal. The year before, the Japanese had a significant advantage.

In this new state of the world, the Japanese are obviously no longer prospering on massive exports of efficiently mass-produced commodity products. Exports fell from an average of 46% of total parent company sales last year to 40% this year. These parent company only figures include sales from the parent company to its

Top Japanese electronics companies

		Electronics sales ($ millions)		Total sales ($ millions)		Operating income ($ millions)	
Rank	Company	1986	1985	1986	Percentage change in yen from 1985	1986	Percentage change in yen from 1985
1	**Matsushita**	$21,900	$17,889	$31,335	-9%	$2,135	-44%
2	**NEC**	16,779	12,361	16,779	5%	632	-37%
3	**Hitachi**	15,128	12,222	33,210	-3%	1,471	-30%
4	**Fujitsu**[1]	12,256	8,733	12,256	6%	393	-32%
5	**NTT**[1]	9,729	7,439	36,668	5%	4,945	-5%
6	**Sony**	9,076	7,333	9,076	-7%	53	-75%
7	**Toshiba**	8,105	8,889	22,655	-2%	353	-58%
8	**Mitsubishi**	6,300	4,167	14,435	6%	467	24%
9	**Sharp**[1]	6,200	4,150	7,868	-5%	—	—
10	**Canon**	5,800	3,450	6,091	-7%	206	-66%
11	**Sanyo**	5,700	4,767	8,226	-21%	53	-89%
12	**Ricoh**	3,400	2,838	4,507	0%	160	-28%
13	**Oki**[1]	2,791	2,272	2,791	4%	—	—
14	**TDK**	2,643	2,372	2,643	-10%	269	-48%
15	**Alps**[1]	2,400	1,900	2,532	3%	69	-55%
16	**Pioneer**	2,377	1,816	2,377	2%	—	—
17	**Omron**	1,908	1,540	1,908	0.5%	112	-32%
18	**Minolta**[1,2]	1,700	1,457	2,055	-3%	103	-33%
19	**Citizen**[1]	1,600	1,692	1,819	-3%	—	—
20	**Kyocera**	1,575	1,289	1,892	-1%	232	-2%

[1] Consolidation by Japanese accounting conventions, which differ slightly from U.S. Securities and Exchange Commission rules used by the rest of the companies.

[2] Preliminary estimate before release of final consolidated results.

1986 figures are converted at ¥146 = $1.

1985 figures are as originally reported last year using ¥180 = $1.

overseas subsidiaries for sale abroad, but do not include sales of goods produced by the overseas subsidiaries themselves.

New winners

And the new environment is producing some new winners and losers. Somewhat surprisingly, the companies doing best so far in the new world of the high yen are the specialized makers of passive components. Fattest margins this year belonged to Kyocera (12% operating, 6% net) and TDK (10% operating, 4% net). Omron also did better than most of the major computer makers, maintaining a 6% operating margin.

"The components makers were more flexible," notes Sharil Osgood, an analyst who tracks Japanese electronics companies for James Capel Securities Inc. in San Francisco. "Their products are easier to make offshore, and they already had facilities. Alps increased its offshore production 80% last year, and it just upped its earnings projections for next year."

Also outperforming its larger and usually more profitable rivals this year was Mitsubishi Electric. The company tied Fujitsu for most growth in revenue (6%), and it was the only one of the top 20 to increase its operating income. What's Mitsubishi selling so successfully? Defense electronics, for one thing.

> Who saw significant sales growth? Fujitsu, 6%; Mitsubishi, 6%, Nippon Telegraph and Telephone, 5%; NEC, 5%; and Oki Electric 4%

At 7% operating and 4% net, consumer giant Matsushita maintained better margins than the computer makers. The company did well on sales of domestic consumer products, raising its domestic sales from 63% to 70% of its total revenue, as it developed new products ranging from digital audio equipment to automatic bread makers and electronic pillows.

In marked contrast to Japan's traditional strategy of export-led growth, those companies that did the best this year were the ones that exported the least. Which companies saw significant sales growth? Fujitsu, 6%; Mitsubishi, 6%; Nippon Telegraph and Telephone (NTT), 5%; NEC, 5%; and Oki Electric Industry Co. Ltd., 4%. Which companies exported the least? Pretty much the same crew: NTT, 0%; Fujitsu, 18%; Omron, 18%; Mitsubishi, 24%; and Oki, 24%. ☐

Net income ($ millions) 1986	Percentage change in yen from 1985	Operating income as a percentage of sales	Net income as a percentage of sales	Sales per employee	Net income per employee	Return on equity	Exports	Fiscal year ended
$1,121	-34%	7%	4%	$230,600	$8,200	8%	30%	11/86
103	-45%	4%	1%	166,100	1,000	5%	28%	3/87
676	-34%	4%	2%	206,300	4,200	6%	29%	3/87
148	-44%	3%	1%	137,300	1,700	3%	18%	3/87
1,014	-20%	13%	3%	123,500	3,400	—	—	3/87
287	-43%	1%	3%	186,500	5,900	7%	62%	10/86
234	-43%	2%	1%	161,800	1,700	4%	29%	3/87
73	-68%	3%	1%	197,700	1,000	3%	24%	3/87
142	-42%	—	2%	147,100	2,600	6%	53%	3/87
73	-71%	3%	1%	171,600	2,100	4%	74%	12/86
14	-94%	1%	0.2%	117,500	200	4%	49%	11/86
75	-29%	4%	2%	156,000	2,900	5%	31%	3/87
15	+329%	—	0.5%	214,700	1,200	-2%	24%	9/86
106	-49%	10%	4%	163,300	6,600	6%	41%	11/86
29	-55%	3%	1%	126,600	1,500	5%	29%	3/87
37	+319%	—	2%	191,100	3,000	2%	40%	3/87
21	+18%	6%	1%	142,800	1,600	1%	18%	3/87
38	-50%	5%	2%	—	—	5%	79%	3/87
23	-6%	—	1%	—	—	3%	61%	3/87
120	-5%	12%	6%	118,300	7,500	6%	44%	3/87

Source: ELECTRONIC BUSINESS

DATABASE

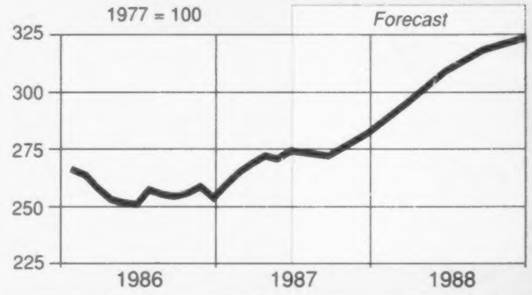
Computers and office machinery

The computer, peripherals and related equipment market continues its upswing. Production is running about 10% above the June 1986 level, its most recent low. Employment also edged up in June and, though still well below 1985's levels, is expected to increase steadily through 1988 as production increases. The decline in the dollar has influenced buyers abroad to buy more U.S. computer equipment. Exports in the first half of 1987 were $8.6 billion, 19% higher than the year-ago period. Imports also picked up, thus widening the trade gap, but further signaling the recovery of the computer market and the willingness of businesses to increase investment in new machinery and replace older models.

Edited by LINDA STALLMANN

Computer industrial production

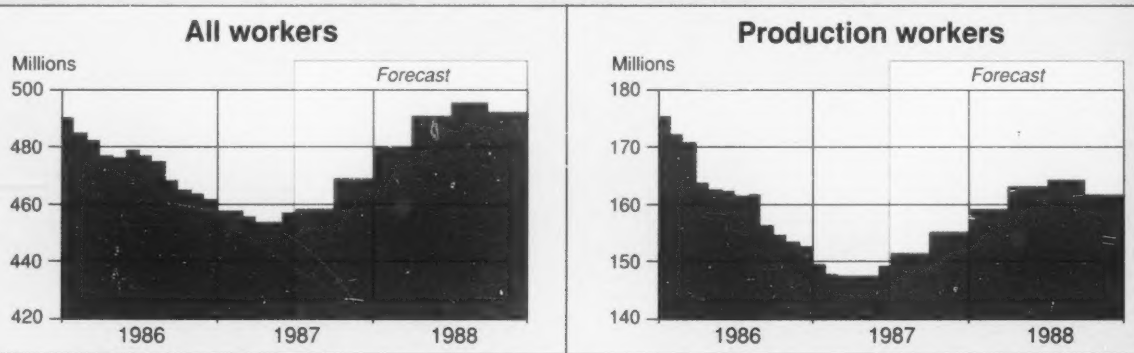
Seasonally adjusted index (SIC 357)



June 1987	May 1987	June 1986
274.6	271.0	250.7

Source: Federal Reserve Board; Forecast: Cahners Economics

Computer industry employment



All workers

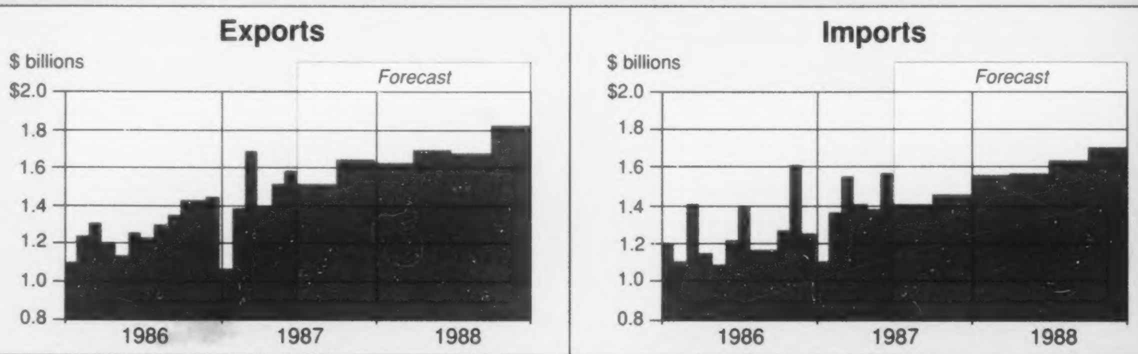
June 1987	May 1987	June 1986
457.2	453.7	479.3

Production workers

June 1987	May 1987	June 1986
149.2	147.6	162.3

Source: U.S. Department of Labor; Forecast: Cahners Economics

Computer exports and imports



Exports

June 1987	May 1987	June 1986
$1.587	$1.519	$1.260

Imports

June 1987	May 1987	June 1986
$1.574	$1.386	$1.224

Source: U.S. Department of Commerce; Forecast: Cahners Economics

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OCTOBER 15, 1987

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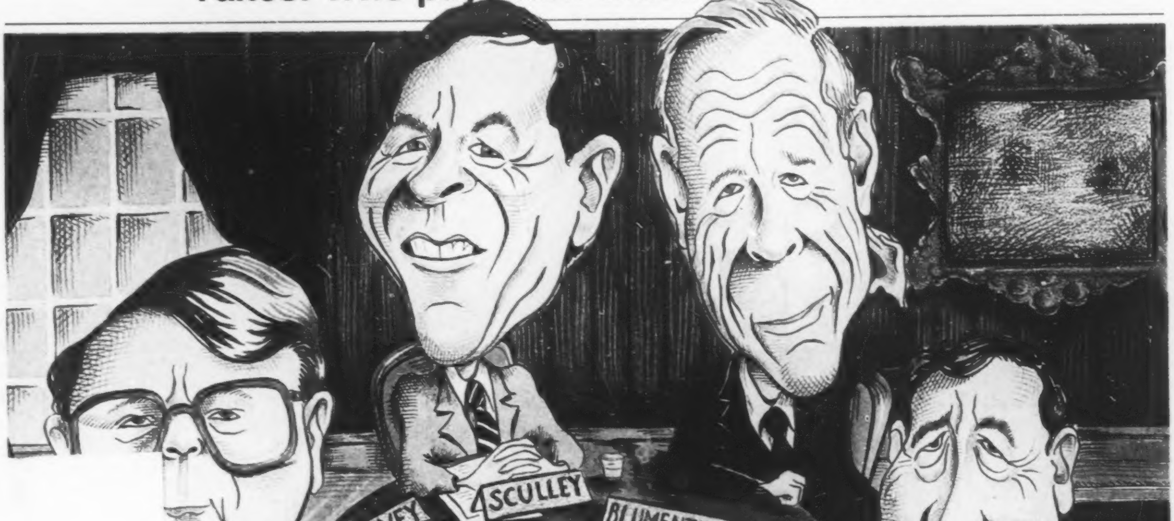

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The million-dollar club: Five execs who earned more than $1 million apiece in 1986 PAGE 44

Computer Business
OFFSHORE PROGRAMMING

Electronic Business

VOL. 13, NO. 20

OCTOBER 15, 1987

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER AND SYSTEMS COMPANIES

A Quest for Excellence

Final Report to the President

by the President's
Blue Ribbon Commission
on Defense Management

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BLUMENTHAL
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The market for secure military systems based on the NSA's secret specifications should hit $1 billion this year.

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In Japan, whether you win or lose often depends on how you play the game. Companies that don't understand how Japanese society works will never penetrate the market. Companies that do will succeed.

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Cover illustration: Dorothy Ahle

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BPA ABP

Communication equipment production drags in the U.S.

Hewlett-Packard bets on Siemens' ISDN for a good reason. Is it also good for AT&T?

Four years ago, AT&T Technologies, née Western Electric, saw an opportunity in Europe. Having itself gone through the experience of deregulation in this country, and still painfully evolving from a monopoly to a free-market participant, the then-manufacturing unit of the Bell System entered into a joint venture with N.V. Philips GL of the Netherlands. AT&T had hoped that the winds of deregulation that were already reaching Europe would create a ready market for the company, and chose a prestigious partner to cash in on that market, thus counteracting the expected decline in — and increasing competition for — communication equipment in the United States. With the yen very cheap, it reasoned that Japanese manufacturers would be the main beneficiaries of deregulation in the United States, and domestic production here would stop growing.

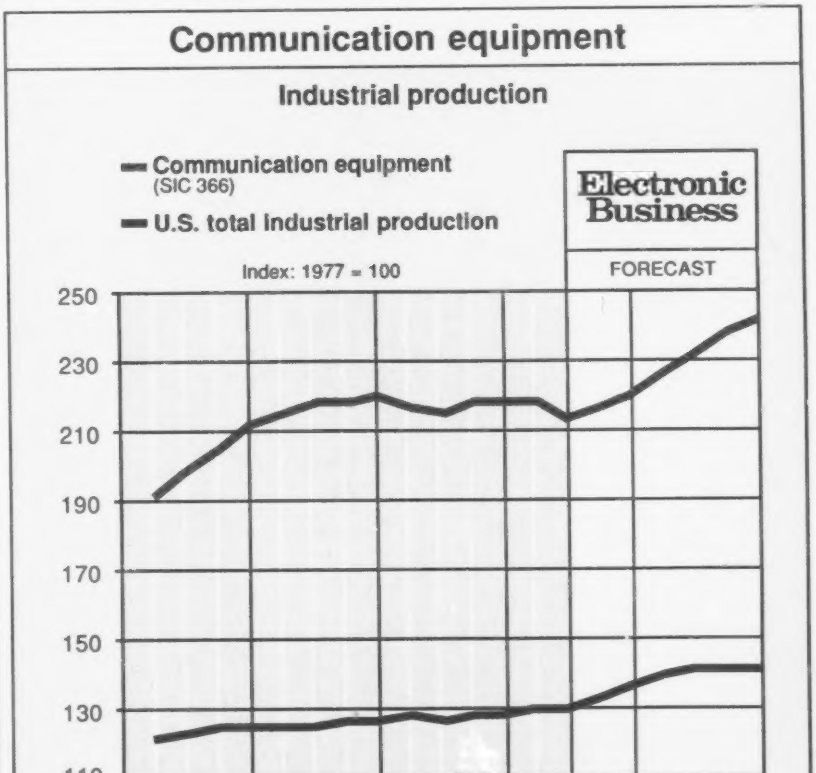
Production of communication equipment in the United States had, in those days, so much momentum from market demand that it increased by 8% in 1985, but that was the last growth year. The industrial production index for communication equipment, compiled by the Federal Reserve Board, declined slightly in 1986. So far, in 1987, it has kept even with last year, but Cahners Economics forecasts that the index will end this year up a bit, just enough to make up last year's loss.

Cahners expects that 1988 will see a return to 8% growth. To achieve this, the U.S. industry is counting on help from the increasingly dear yen, which makes imported Japanese communication gear more expensive. But the yen, and Japan's deregulation of its own monopoly, should also make U.S.-made communication gear cheaper and more marketable in Japan. So far, however, AT&T has not had much success in Japan even two years after its Japanese counterpart, Nippon Telegraph and Telephone, went private.

AT&T hasn't fared much better in Britain, where British Telecom became a private company two years ago. And, so far, the major communication utilities in the two largest continental markets — the Deutsches Bundespost and the French PTT — remain firmly in the hands of the respective governments and as committed as ever to buying from domestic suppliers. Moreover, Siemens AG in Germany has reportedly taken a lead in the development of ICs and systems for the Integrated Services Digital Network (ISDN), a proposed 192-kilobit-per-second service which may become an international standard for the simultaneous transmission of voice and data.

Whether the equipment for Europe is made locally or in the United States, Hewlett-Packard Co. hopes to cash in on the expected demand for instruments and ATE that can test the complex combinations of digital and analog circuits. "ISDN will affect the design of PBXs, central office equipment, line cards, modems, facsimile, digital phones and cellular phones," says John E. Scruggs, general manager of HP's Manufacturing Test Division. So far, HP is betting on Europe: its ATE gear for ISDN is based on Siemens' design.

ALBERTO SOCOLOVSKY

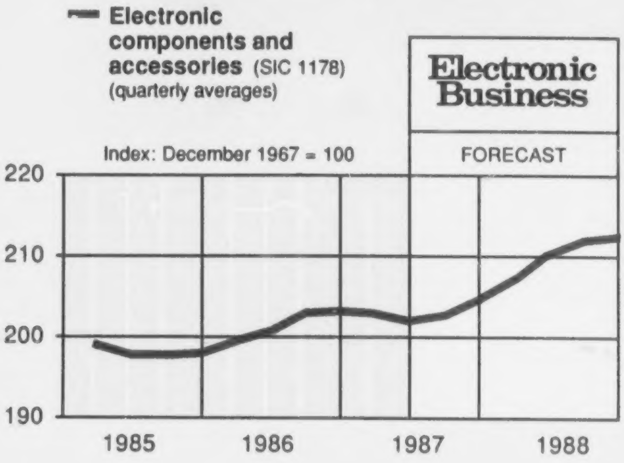

Communication equipment

Industrial production

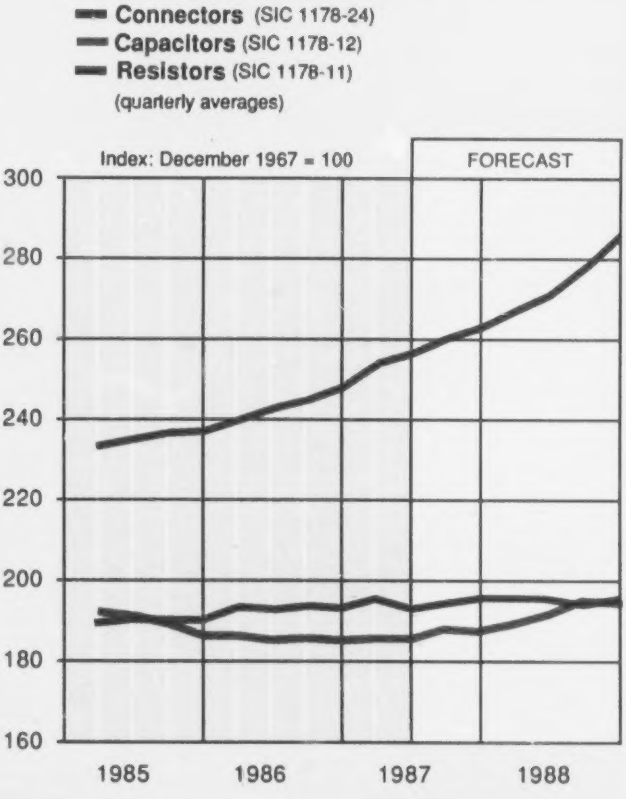
Historical data: Federal Reserve Board; Forecast: Cahners Economics

Producer price indexes

Electronic components



Passive components



Historical data: Bureau of Labor Statistics; Forecast: Cahners Economics

Electronic components
According to the latest report by the U.S. Labor Department, the producer price index for electronic components and accessories fell 0.3% in the second quarter from the first quarter, leaving prices just 0.7% above last year's levels. Prices are expected to remain fairly weak through the end of the year, but rising demand for components will result in spot shortages of certain types of components in 1988. Many factories producing VLSI chips are already operating at capacity, according to the Semiconductor International Association. Electronic components prices are expected to rise just 0.7% this year and 3.7% next year.

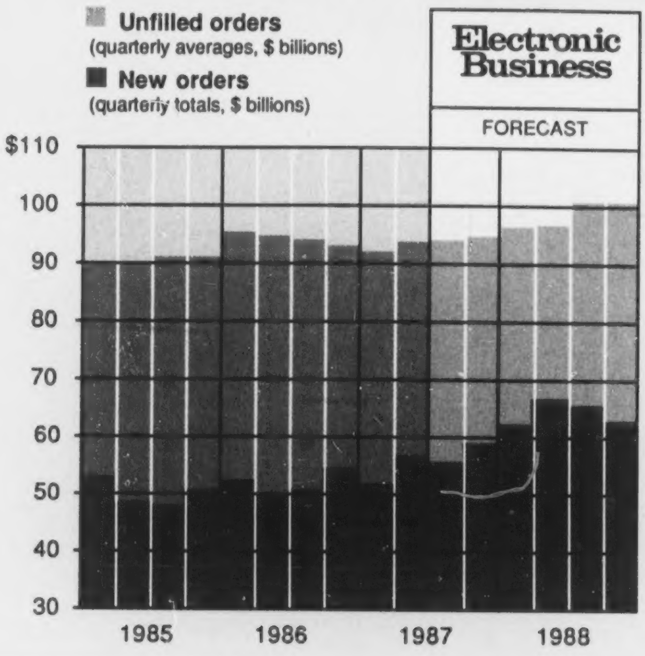
Capacitors
Producer prices of capacitors inched upward by half of a percentage point in the second quarter from both the prior and year-ago quarters. Only small price increases are likely through the end of 1987. Higher energy prices have put some upward pressure on manufacturing costs of aluminum capacitors, but a more stable yen has kept the lid on ceramic prices. The outlook for capacitor prices in 1988 depends on the strength of demand for capacitors. A 20% rise in U.S. factory sales of capacitors will push up producer prices by at least 3.4% in 1988.

Resistors
After the first quarter's substantial increase, resistor prices fell 1.2% in the second quarter, level with last year's spring prices. Abundant supplies have meant price increases have been difficult to implement. Supplier margins are now low and in an attempt to raise margins, modest rises in prices are expected. But price increases won't stick for mature products. Resistor prices are expected to rise only 0.8% this year with an even more moderate 0.5% advance in 1988.

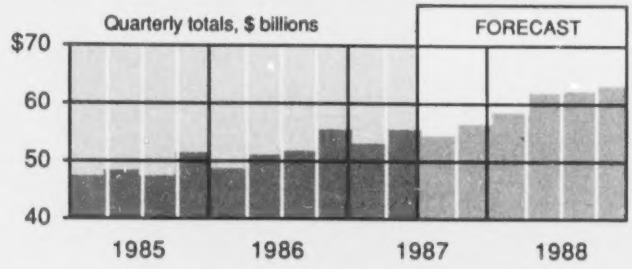
Connectors
While most other components have experienced relatively small price gains or have even declined in the first half of 1987, prices of connectors have been rising sharply. Advancing 0.9% in the second quarter of 1987, producer prices of connectors now stand 5.8% above last year's levels. Strengthening demand from end-users, especially for insulation-displacement connectors and selected two-piece printed circuit connectors, means prices are holding. A 6.2% increase in connector prices this year will be followed by another 6.8% gain next year.

Electrical machinery (SIC 36)

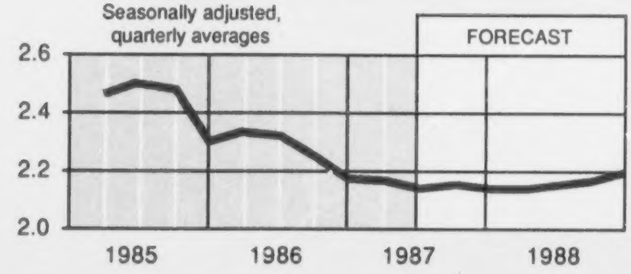
New and unfilled orders



Shipments



Inventory-to-shipments ratio



Historical data: U.S. Commerce Department; Forecast: Cahners Economics

New Orders

Manufacturers of electrical machinery received $57 billion in new orders for the second quarter of 1987. Compared to the same three-month period for 1986, this level represents a 13.8% increase, the largest quarter-to-quarter growth since the third quarter of 1984. All segments of electrical machinery enjoyed healthy increases, particularly electronic components, 15.9%; household appliances, 15.1%; and communication equipment, 13.5%. However, due to the slackening in military orders for communication equipment and softening in the consumer electronics sector, growth in new orders should be about 7.6% for 1987. Expect double-digit growth in 1988 at around 14.7%.

Unfilled orders

Backlogs, which had been falling, are starting to turn around. Although the $93.1 billion figure at the end of the second quarter is below the $93.7 billion total of a year ago, the difference is narrowing. With the solid gains posted for new orders for electrical machinery, backlogs are expected to rise over the remainder of 1987 and most of 1988.

Shipments

Shipments of electrical machinery stood at $20.1 billion for June, historically a good month for this industry. Growth in shipments has been rising slowly, but steadily. Second-quarter shipments are 9.2% above year-ago levels. This growth was fueled by record sales in the consumer electronics categories in spite of overall dampening in consumer spending for other products. Household appliance shipments for April through June skyrocketed 16% compared to the same period last year. On a dollar basis, communication equipment had the largest quarter-to-quarter gain at $1.1 billion. Shipments are expected to increase 6.2% this year and 11.5% in 1988.

Inventory-to-shipment ratio

Electrical machinery manufacturers have been maintaining tight control over inventory levels since the middle of 1986. With shipments on the upswing, the I/S ratio has been shrinking from a peak of 2.5 in mid-1985 to 2.15 in this year's second quarter. Inventory levels are now slowly on the rise as manufacturers, convinced that the economic recovery is for real, prepare for the current expansion. The I/S ratio will start to increase, but will be maintained in the band of 2.15 to 2.21 for the remainder of 1987 and 1988.

TOP PAID EXECUTIVES

Cash is back in style for top management

Cash compensation for the top execs in the industry is on the rise again, at the expense of noncash compensation

By Bruce C.P. Rayner and Linda Stallmann

The average paycheck of the 100 highest paid executives in the electronics industry rose $79,425 to $635,775 in 1986, up 14% over the previous year.

Considering that inflation was just under 2% last year and the electronics industry was beginning to bounce back from one of the worst downturns in history, most executives did reasonably well in terms of cash compensation.

Of the close to 600 executives surveyed in our poll — selected from the four or five top officers at 125 publicly held U.S. electronics firms —the average cash compensation was $295,531, up $32,712, or 12.4%, over the previous year.

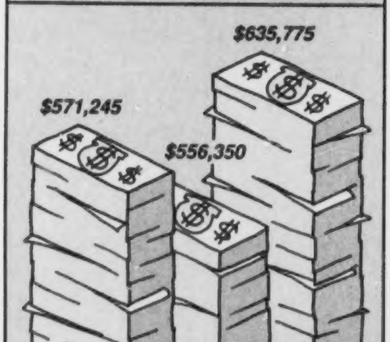
These pay increases include salary and bonuses but exclude stock, stock options, perquisites and other long-term forms of noncash payments. The data for the survey was drawn from proxy statements and annual reports of companies with more than 70% of their revenue derived from sales of electronic goods. No adjustment has been made to aggregate figures as a result of dissimilar fiscal years.

Somewhat contrary to the ELECTRONIC BUSINESS results is a recent survey conducted by the American Electronics Association that indicates the average increase in compensation (salaries and bonuses) for electronics executives has been slipping for the last four years. From a high in 1984 of just over 8%, the AEA reports that salary increases dipped to 7.2% in 1985, 5.9% in 1986, and are down to 5.4% for 1987.

A comparison between the AEA survey — which included 6,700 electronics executives from both private and public companies — and the ELECTRONIC BUSINESS survey implies that the average rate of compensation increase for the top rung of executives in the largest public companies outstrips that of all other electronics executives. While belt-tightening persisted from 1985, through 1986 and into 1987 for most electronics companies, the 120 largest public companies tightened in 1985 but relaxed in 1986.

The two top paid executives — Unisys Corp.'s chairman and chief executive W. Michael Blumenthal and General Instrument Corp.'s executive vice president Frank Drendel — both earned over $2 million in cash in 1986. However, both compensation packages are extraordinary items — caused by a merger, in the case of Unisys, and an acquisition in the case of GI. They do not imply that salaries for high-tech executives will soon be up with those of Hollywood celebrities and rock stars.

Average compensation is on the rebound for the 100 top paid

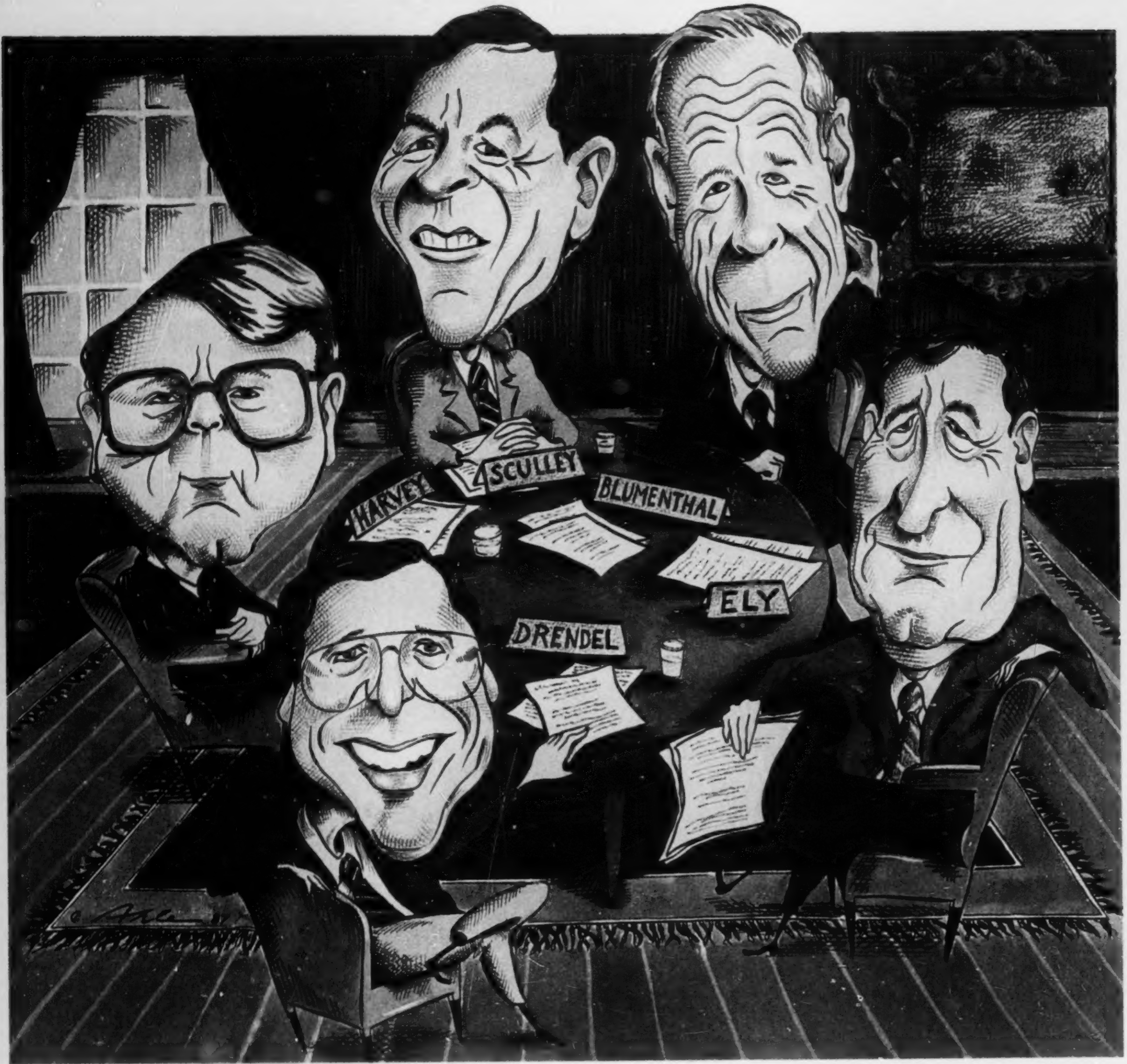


Source: ELECTRONIC BUSINESS

Drendel received a whopping $2 million "transition bonus" and an extra $39,361 in interest payments when General Instrument bought a division of M/A-COM Inc., which Drendel ran. Under the agreement reported in the 1987 GI proxy statement, Drendel's employment contract runs through February of 1988.

Blumenthal, the former chairman of Burroughs Corp., received $545,000 in salary, $463,000 as an annual bonus and $1.17 million in "other cash compensation" when he moved into the Unisys top job after Sperry Corp. and Burroughs combined forces. These two cases represent the first time the $2 million barrier has been broken since the rosy days of 1984 when John Sculley, president and chief executive of Apple Computer Inc., took home total cash compensation of $2.16 million.

Overall, there has been a steady increase in the size of the million-dollar club since ELECTRONIC BUSINESS began keeping score on cash compensation five years ago. In 1983, there were only two members of the million-dollar club; by 1985 there were five; and last year there were six. But compared with industrialist-financiers like Lee Iacocca and T. Boone Pickens, these guys are still small fry. Nonetheless, there is a growing



The million dollar club: (clockwise from bottom) Frank M. Drendel, General Instrument Corp., $2,144,785; George B. Harvey, Pitney Bowes, Inc., $1,103,168; John Sculley, Apple Computer Inc., $1,697,706; W. Michael Blumenthal, Unisys Corp., $2,177,631; Paul C. Ely, Convergent Technologies Inc., $1,188,750

Dorthoy Ahle

awareness in the electronics industry that the stakes are getting higher. When it comes to attracting and keeping top decision makers, aggressive bargaining over complex compensation packages could lead to more club members.

Compensation packages at the top, however, grew substantially faster than cash dispersals at the bottom half of the list, thereby distorting the overall picture. For example, Blumenthal and Drendel increased their compensation packages by 423% and 875%, respectively, over the previous year. Further down the list, cash compensation increased at a more moderate rate.

The average compensation for the bottom 10 executives on the list grew at a 12.9% rate last year from an average of $366,351 in 1985 to $413,659 in 1986. Similarly, the 10 executives in the middle of the list — ranking 46 to 55 — increased their compensations by an average of 13% from $474,055 in 1985 to $535,504 in 1986.

Whither IBM?

One glaring exception to the improving state of executive pay is IBM. Of the five Big Blue officers that made the list this year, all posted declines in their salaries: chairman John Akers dropped 3.2% between 1985 and 1986; and Jack Kuehler, senior vice president, slipped 37.3%. Kuehler had the biggest decline of the 100 executives on the list. Last year, former IBM chairman John Opel took an 18% pay cut and dropped out of the million-dollar club.

The reason for IBM's poor showing in executive pay, says Stuart Sadick, an associate with Russell Reynolds Associates Inc., a management consulting firm that specializes in compensation, is a result of the company's "high profile." Because IBM's earnings slipped almost 27% in 1986, the top corporate officers had to give a message to both the company and the industry that they meant business. It was a "philosophical" issue, comments Sadick.

One-fifth of all executives on the top 100 list took some kind of hit in the wallet last year. In addition to Big Blue, three other companies — which saw earnings decline — also cut cash payments to their top personnel: Avnet Inc., Honeywell Inc. and Xerox Corp.

In total, 15 out of 75 executives, or 20%, saw their salaries decline between 1985 and 1986. (Data for only 75 of the 100 executives is available for both 1985 and 1986.) Still, this 20% compares favorably with the 28% of executives between 1984 and 1985 that saw a decline in their compensation.

Give me cash

One reason for the 1986 rebound is the growing preference for cash payments over stocks and other noncash payments. Experts agree that the Tax Reform Act of 1986 is a major catalyst in this shift to cash, but warn that even more significant changes in accounting procedure are in store.

"Executives have always liked cash," comments Tim Haigh, managing director the Cambridge, Massachusetts-based consulting firm of W.T. Haigh, even though historically they have placed a higher degree of importance on equity. This trend can be expected to continue. However, "there is still a strong incentive to build ownership," says Haigh, so stock options will remain a major part of executive compensation.

The real issue is what kind of stock

The guys at the top

In 1986, six electronics executives made over seven figures in salary and bonuses. But cash compensation — though highly desirable —is only one side of the compensation picture. Their net worth includes big equity bonuses in the form of stock options.

W. Michael Blumenthal, the chairman and chief executive of newly formed Unisys Corp. and former chairman of Burroughs Corp., earned $545,000 in salary, a $463,000 annual bonus plus $1,169,631 in "other cash compensation." He received total cash compensation of $950,000 in 1984 and $416,250 in 1985.

As of this winter, Blumenthal held 10,076 shares of common stock in his company and had options on 53,400 more. In total, these stocks are valued at around $6.7 million. Between Jan. 1, 1984, and Feb. 9, 1987, he made a total of $5,782,494 on options exercised.

Frank M. Drendel is the exception to the rule in this group of top paid executives. Unlike his seven-figure peers, the new executive vice president of General Instrument Corp. got the lion's share of his compensation in the form of a one-time $2 million "transition bonus."

Drendle was the former president of M/A-COM Inc.'s Cable/Home Communications business that General Instrument bought in September 1986. When the company purchased the new business, Drendel came with the deal. His salary from General Instrument in 1986 was $105,424 and he is contracted to receive a $230,000 salary plus a bonus of at least $120,000 for fiscal year 1987, ending Feb. 29, 1988.

Because of Drendel's recent shift, his equity share in General Instrument is small.

John W. Dixon, the former chairman and chief executive of E-Systems Inc., retired in April of this year after making $1,789,480 in 1986. Since ELECTRONIC BUSINESS began reporting the top-paid executives in 1983, Dixon has consistently made over $1 million. Now that he has retired, the 67-year-old Dixon will be retained as a consultant with E-Systems until he is 70 and will receive retirement benefits equal to 50% of his income for the rest of his life.

According to the E-System's proxy statement of April 1987, Dixon holds 323,887 shares —1.1% of total stock outstanding —of the company's common stock valued at about $11.3 million. He was granted 25,000 options during 1986.

John Sculley might be 20 years younger than Dixon but they have one thing in common: they both have earned seven-digit salaries for the past five years. Sculley, the 47-year-old chairman and chief executive of Apple Computer Inc., who joined the company from Pepsi-Cola Co. in 1983, earned a $1 million bonus in 1986 on top of other cash compensation of $697,706.

Sculley's equity holdings in Apple are equally impressive. He held nearly 3,800 shares and had options on 174,998 shares of common stock, which, at the end of last year, were valued at about $7.2 million in total. He sold 107,000 shares for a total of about $4.4 million. Over the last five years, Sculley received 500,000 options on Apple stock and has made a profit of $175,000 on exercising stock options.

Paul C. Ely, chairman of Convergent Technologies Inc., the $305 million computer network company, earned $288,750 in salary plus a bonus of $900,000 in 1986. Written into Ely's employment contract when he joined Convergent in 1985 from Hewlett-Packard Co., was the guarantee of a $25,000 monthly salary, a 1985 cash bonus of $1 million and a 1987 bonus of $700,000.

As for Convergent's 1986 proxy statement issued in last April, Ely has options on 900,000 shares of Convergent common stock valued at about $5 million.

George B. Harvey, chairman, chief executive and president of Pitney Bowes Inc., the Stamford, Connecticut-based maker of measurement equipment, earned $417,470 in long-term bonuses on top of the $685,698 in salary and cash earned. Although he is low man in the top-paid echelon, his equity holdings in Pitney Bowes put him near the top.

Harvey holds 97,304 shares of common stock in Pitney Bowes, representing nearly half of the shares held by all officers and directors of the company as of March 1987. At that time, his stock was valued at about $4.2 million. During 1986, Harvey was granted options on 14,600 shares of common stock and realized a gain of $1,204,949 on the exercise of those options. □

options. Besides tax reform, companies have to contend with the attempts by the Financial Accounting Standards Board (FASB) to change the way incentive stock options (ISOs) are accounted for. New regulations might be out by next year. The potential for major restructuring in equity compensation is looming, warns Haigh.

Because the values of large public companies are determined by the short-term financial markets, they have traditionally been driven by the vagaries of Wall Street. "These companies are coming to see the costs involved in focusing too heavily on the short term," comments Sadick of Russell Reynolds. They want to continue to manage profitability but not at the expense of longer-term product development. The issue is finding the right balance.

Looking to the long term

One key issue that many companies are grappling with is how to tie long-term performance to compensation packages. Most public companies pay out bonuses based on the current year's stock performance to supplement executive salaries, but these are sometimes contrary to the strategic goals of the company. Although they have been around for awhile, long-term compensation packages, used to counter this shortsightedness, are just now becoming more popular.

According to Anthony Price, the managing director of the San Francisco office of Russell Reynolds, three-year plans are the most desirable long-term compensation packages. They are based on an index of performance that matches the executive's motivation with the long-term interests of shareholders. The first bonus payment is not made until after three years, which is an added incentive for the executive to make a longer term commitment to the corporation.

Sibson & Co., a human resource management firm specializing in compensation packages, released a report recently that spells out the popularity of various types of long-term packages that are most favored. Like Price, Sibson's report from a 1986 survey claims that 45% of all companies in general industry showed a preference for the three-year plan. Return on equity; target earnings; return on capital; and earnings per share growth were all popular as measures for tying long-term compensation in with corporate performance, Sibson reports.

Even though corporations want to attract and keep executives for the long term, many executives are equally concerned that their positions are less certain during these days of increased merger and acquisition activity. They are looking for some assurance that, if the company gets bought out and they are sent packing, they will end up with adequate compensation. Negotiated "termination contracts" are gaining popularity, claims Edward Unterberg, managing director of Russell Reynolds' high-tech business in its Chicago office, whereby executives get a set amount of money if they get terminated through a takeover. Unterberg insists that a termination contract is not a golden parachute.

However, most experts agree that huge separation payments are not as common these days. The Tax Reform Act of 1984 placed an excise tax of 20% on excessive parachute payments — defined as payments three times above the average salary for the last five years. This reform obviously has reduced the parachute appeal. However, according to Neal Mugherini, a senior tax manager at the Big Eight accounting firm of Ernst & Whinney, the Tax Reform Act of 1986 has slightly lessened the penalty. Now, Mugherini says, if the executive can prove that the excess payment is reasonable compensation for the separation, the excise tax can be lowered.

One-fifth of all executives on the top 100 list took some kind of hit in the wallet last year

But this is not all that the 1986 tax reform has done. By raising the capital gains tax rate from 20% to 28% and lowering the personal income tax rate from 50% to 28%, the difference between after-tax gain from stocks and after-tax income on salary is removed. This is putting a severe limit on the popularity of incentive stock options. It tends to hurt small companies more than large companies because they are often limited in the cash compensation they can offer and must rely on incentive stock options and equity.

Another recently released Sibson report, based on a national survey of large U.S. corporations, states that 73% of those companies that made a decision concerning the use of ISOs will eliminate them or substantially reduce eligibility by employees for these options.

Looking further down the road, there is a strong expectation that the differential between the capital gains tax rate and the personal income tax rate will be restored when a new administration gets to the White House in 1989. This tends to dilute the significance of the long-term implications of the new tax bill on all forms of equity compensation. As Haigh quips, "the only thing constant about the tax laws is change."

FASB values ISOs

But ISOs are being attacked on another flank. The Financial Accounting Standards Board has been looking for a way to establish a basis for a charge to earnings on ISOs. Currently, when ISOs are issued there is no requirement to put a value for the unexercised options on the company books. FASB argues that there should be some valuation on the books because the options represent real value in terms of motivation to the employee.

FASB has been debating for nearly three years on the correct method for valuing the option and when exactly the value should be put on the books. For example, should a complex future market value of the stock be used or should the fair market value be put on the books? The decision is important because once a company charges the value to earnings, that value cannot be erased. Haigh claims that the board will come out with a position paper for debate by the end of the year and could possibly have something ready for the books by early 1988.

"We don't think they should do it," says Kenneth Hagerty, vice president of government operations at the American Electronics Association, referring to FASB. Many organizations, including the Big Eight accounting firms, are dead set against the FASB's attempts to value ISOs. Most experts agree, it will be the small- to medium-sized companies that will be hit the hardest because they place the heaviest emphasis on equity plans and generally do not have much cash. It is argued that they will not be able to attract and keep good management if ISOs are taken away.

Tables follow ▷

Top paid executives

Rank	Executive/age	1986 salary	Percentage change from previous year	Company	Position
1	**W. Michael Blumenthal**/61	$2,177,631	+423.2%	Unisys	Chairman, CEO
2	**Frank M. Drendel**/42	2,144,785	+874.9%	General Instrument	Executive VP
3	**John W. Dixon**/67	1,789,480	+5.1%	E-Systems	Chairman, CEO
4	**John Sculley**/47	1,697,706	+61.0%	Apple Computer	President, CEO
5	**Paul C. Ely Jr.**/55	1,188,750	-8.2%	Convergent Technologies	Chairman
6	**George B. Harvey**/55	1,103,168	+72.8%	Pitney Bowes	Chairman, president, CEO
7	**Edward M. Esber Jr.**/34	943,237	NA	Ashton-Tate	Chairman, CEO
8	**Charles E. Exley Jr.**/57	938,142	+3.6%	NCR	Chairman, president, CEO
9	**John A. Young**/54	919,654	+7.0%	Hewlett-Packard	President, CEO, chairman
10	**Cees Bruynes**/55	918,392	+13.4%	N.A. Philips	Chairman, president
11	**William G. Moore Jr.**/47	886,086	+87.0%	Recognition Equipment	Chairman, president, CEO
12	**David T. Kearns**/56	874,918	+9.5%	Xerox	Chairman, CEO
13	**Paul G. Stern**/48	833,821	+4.6%	Unisys	President
14	**Bernard L. Schwartz**/61	832,874	NA	Loral	Chairman, CEO
15	**John C. Lewis**/51	830,963	+30.6%	Amdahl	President, CEO
16	**Robert M. Price**/56	828,195	+69.3%	Control Data	Chairman, president, CEO
17	**Joseph B. Flavin**/58	815,780	NA	Singer	Chairman, CEO
18	**Joseph A. Boyd**/64	796,027	+16.9%	Harris	Chairman
19	**Jim P. Manzi**/35	794,572	NA	Lotus	President, CEO
20	**Kenneth H. Olsen**/60	755,003	+0.0%	DEC	President
21	**Gregory J. Liemandt**/44	720,000	NA	Uccel	Chairman, CEO
22	**Anthony R. Hamilton**/62	712,954	-11.5%	Avnet	Chairman, CEO
23	**Leon Machiz**/62	712,954	-11.5%	Avnet	Vice chairman, COO, president
24	**John F. Akers**/52	711,900	-3.2%	IBM	Chairman
25	**Melvin Howard**/52	703,429	+46.4%	Xerox	Vice chairman, subsidiary officer
26	**David R. Tacke**/64	685,034	+5.8%	E-Systems	President
27	**Joe M. Henson**/53	683,894	+1.8%	Prime Computer	President, CEO
28	**Norbert R. Berg**/55	672,767	+69.6%	Control Data	Deputy chairman
29	**James F. McDonald**/47	654,208	+19.7%	Gould	Chairman, president, CEO
30	**Paul J. Rizzo**/59	652,576	-9.6%	IBM	Vice chairman
31	**John T. Hartley**/56	630,617	+21.2%	Harris	President, CEO
32	**Eugene R. White**/55	628,046	+19.5%	Amdahl	Chairman
33	**Thomas A. Vanderslice**/55	625,964	+21.2%	Apollo Computer	Chairman, president, CEO
34	**John A. Rollwagen**/46	621,972	+22.6%	Cray Research	Chairman, president, CEO
35	**John V. Roach**/47	608,899	+46.9%	Tandy	Chairman, CEO, president
36	**Stephen J. Jatras**/61	596,667	+28.4%	Telex	Chairman, CEO
37	**William F. Schmied**/58	589,860	NA	Singer	President, COO
38	**William J. Weisz**/59	586,980	+28.6%	Motorola	Vice chairman
39	**Bert L. Zaccaria**/42	581,774	NA	Xidex	Executive VP
40	**William F. Glavin**/54	581,318	-6.3%	Xerox	Vice chairman
41	**Dean O. Morton**/54	578,906	+8.7%	Hewlett-Packard	Executive VP, COO
42	**Winston R. Wallin**/61	566,313	NA	Medtronic	Chairman, president, CEO
43	**Dean P. Phypers**/58	563,597	-9.6%	IBM	Senior VP
44	**Edson W. Spenser**/60	561,900	-28.8%	Honeywell	Chairman, CEO
45	**C. Peter McColough**/64	553,683	-1.2%	Xerox	Chairman, executive committee
46	**George B. Beitzel**/58	551,342	-9.4%	IBM	Senior VP
47	**Joseph R. Canion**/42	550,004	+49.8%	Compaq Computer	President, CEO
48	**Stanley A. Wainer**/60	550,000	+22.2%	Wyle Laboratories	Chairman, CEO
49	**Frank C. Lanza**/55	548,669	NA	Loral	President, COO
50	**Robert W. Galvin**/64	543,124	+0.6%	Motorola	Chairman

(Continued)

Top paid executives (continued)

Rank	Executive/age	1986 salary	Percentage change from previous year	Company	Position
51	**Jack D. Kuehler**/54	$531,447	-37.3%	IBM	Senior VP
52	**William T. Ylvisaker**/63[1]	527,215	-22.7%	Gould	Chairman
53	**Robert J. Aplin**	523,086	+64.9%	Gould	Group VP
54	**Stephen R. Levy**/46	520,000	NA	Bolt Beranek & Newman	Chairman, CEO
55	**John F. Mitchell**/58	510,155	+33.3%	Motorola	President
56	**David A. Bossen**/60	509,130	+17.0%	Measurex	President, CEO
57	**E. Joseph Zemke**/46	506,780	+67.6%	Amdahl	COO
58	**Jerry R. Junkins**/49	500,000	+32.5%	Texas Instruments	President, CEO
59	**John R. Herring**/55	500,000	+53.4%	Wyle Laboratories	Executive VP
60	**Charles M. Clough**/58	500,000	+41.5%	Wyle Laboratories	President, COO
61	**Roy E. Folk**/40	496,375	NA	Ashton-Tate	Executive VP, general mgr.
62	**Walter F. Raab**/62	493,000	+7.8%	AMP	Chairman, CEO
63	**Delbert W. Yocam**	491,717	+67.8%	Apple Computer	COO
64	**William V. Campbell**	480,432	+77.1%	Apple Computer	Executive VP
65	**James L. Bast**/50	478,783	+56.7%	Pitney Bowes	President, Dictaphone Corp.
66	**Thomas R. Loemker**/56	478,009	+56.9%	Pitney Bowes	President, Business Systems
67	**Lester L. Colbert Jr.**/52	477,820	NA	Xidex	Chairman, president, CEO
68	**W.J. Sanders III**/50	477,010	+6.7%	Advanced Micro Devices	Chairman, CEO
69	**Paul A. Allaire**/48	474,918	NA	Xerox	President
70	**Frank W. McBee Jr.**/67	468,156	-2.7%	Tracor	CEO
71	**Gary B. Filler**/45	468,050	NA	Xidex	Executive VP, CFO
72	**David T. Mitchell**/44	462,124	+80.5%	Seagate Technology	President, COO
73	**Jack C. Davis**/48[2]	460,641	NA	Dataproducts	Chairman, President, CEO
74	**Mark Shepherd Jr.**/64	460,020	+1.1%	Texas Instruments	Chairman
75	**James A. Unruh**/46	459,429	NA	Unisys	Senior VP
76	**Bernard S. Appel**	457,768	NA	Tandy	President, Radio Shack Div.
77	**Edson D. de Castro**/48	452,870	+20.8%	Data General	President
78	**Walter J. Zable**/71	451,285	+10.2%	Cubic	Chairman, president, CEO
79	**Jerry K. Pearlman**/47	448,000	+21.8%	Zenith Electronics	Chairman, president, CEO
80	**Frank G. Hickey**/59	443,667	+13.7%	General Instrument	Chairman, CEO, president
81	**Frank Hopkins**/61	442,924	+9.2%	N.A. Philips	Executive VP
82	**Roger W. Johnson**/52	440,154	+103.3%	Western Digital	Chairman, president, CEO
83	**Charles M. Denny, Jr.**/56	439,404	NA	ADC Telecommunications	Chairman, CEO
84	**David Simpson**/60	438,605	+6.2%	Gould	Vice chairman
85	**James J. Renier**/57	438,202	-19.5%	Honeywell	Vice chairman
86	**William F. O'Connell Jr.**/59	430,263	+18.7%	Amdahl	Senior VP
87	**William E. Terry**/53	428,595	-2.0%	Hewlett-Packard	Executive VP
88	**Eric Lidow**/73	428,537	+42.8%	International Rectifier	President, chairman, CEO
89	**E.C. Prokopis**/44	427,116	NA	Lotus	Senior financial officer, CFO
90	**Michael P. Lavigna**/46	420,734	NA	Bolt Beranek & Newman	President, COO
91	**A. Lowell Lawson**/49	419,646	+4.9%	E-Systems	Senior VP
92	**E. Gene Keiffer**/57	419,098	+3.7%	E-Systems	Senior VP
93	**H.L. Sparks**[3]	418,763	NA	Tandon	Senior VP
94	**Rhesa S. Farmer**	418,028	+0.3%	Motorola	Executive VP
95	**Hiro Hiranandani**	414,292	NA	Pitney Bowes	Group VP, Business Systems Int'l
96	**Dan H. Wilkie**/43	411,941	NA	Tandon	President
97	**Douglas K. Mahon**	410,526	+100.6%	Seagate Technology	Senior VP, chief technical officer
98	**Elton R. Vogel**/44	410,283	+51.6%	Pitney Bowes	President, Business Supplies
99	**Dean A. Watkins**/64	408,930	+11.6%	Watkins-Johnson	Chairman
100	**An Wang**/66	405,080	+0.0%	Wang Laboratories	Chairman, president, CEO

[1] Retired
[2] Joined company in April 1986
[3] Resigned

Source: ELECTRONIC BUSINESS

INTERNATIONAL SURVEY

How foreign executives view global trade issues

A poll of 80 presidents and CEOs of non-U.S. based electronics companies produces some surprising results

By Carol Suby

The United States is often accused of holding an insular view of itself in relation to the rest of the world. But that may be changing. As the electronics industry becomes increasingly international in nature, U.S. executives are taking a more thoughtful look at the attitudes and ideas of their foreign counterparts.

In an effort to gain a better glimpse of how foreign electronics executives view the world, ELECTRONIC BUSINESS recently conducted a survey of its overseas readers. A total of 1,000 questionnaires were sent to presidents and chief executives of electronics companies located in Africa, Asia, Europe and the Middle East. Of the more than 80 responses received, 74% were from Asian countries, including Japan, 21% were from Europe and the remaining 5% were from Iran, Israel, Jordan, South Africa and Turkey.

Regarding trade issues, 92% of the respondents said they expect to see further U.S. trade reprisals. And, more than half of overseas executives — 63% — believe that certain tariff barriers are unfair. Despite these negative feelings, or because of such fears, nearly 80% of our respondents said that they expect to see an increase of foreign investments in the U.S. electronics industry over the next several years.

The following is a summary of some of the questions we asked.

Data compiled by Nancy McSharry.

What country do you believe is the current technological leader in the world today?

U.S.	82%
Japan	12%
Europe	1%
No opinion	5%

By the year 2000, 52% of the respondents said, America will still be in first place — but 30% said Japan would be the leader.

What are the most important factors in inhibiting non-U.S. firms from entering into strategic alliances or joint ventures with U.S. high-tech companies?

Undue emphasis on short-term profits	29%
Lack of interest in developing a long-term relationship	28%
U.S. insistence on a controlling interest in enterprise	18%
Unwillingness to compromise on minor issues	17%
Other	8%

Across the board, Europeans, Japanese and Asians (outside of Japan) faulted Americans for their ignorance — in the form of failing to study or understand the business mores of foreign countries.

Do you believe the U.S. trade imbalance in electronics with Japan, South Korea and Taiwan could lead to further trade restrictions by the U.S. on imports of non-U.S. manufactured products?

Yes	92%
No	4%
No opinion	4%

Virtually every response from Japan and Europe indicated that unless something changes, reprisals are inevitable in the near future.

Do you believe the non-U.S. electronics companies should have increased access to U.S. military contracts?

Yes	43%
No	34%
No opinion	23%

Europeans — with 56% voting yes — seem to be more interested in earning U.S. government dollars than Pacific Rim executives. Nearly half the respondents from Japan said they do not believe Japan should have access to Pentagon contracts.

Do you believe "anti-dumping" actions and/or tariff barriers unfairly restrict access to U.S. electronics markets?

Yes	63%
No	23%
No opinion	14%

It's no surprise that all 15 presidents and CEOs from Japan — the biggest target for such actions — answered our poll with a resounding, unanimous "yes."

What are the most important factors in preventing increased U.S. market penetration in your country?

Failure to understand the local market	24%
Failure to adapt existing products to the local market	20%
Insufficient service and support	19%
Domestic trade restrictions	11%
Cultural differences	9%
Language	8%
Other	9%

If the U.S. did its homework before moving products into foreign markets, the need for trade restrictions might diminish, some respondents said.

TAXES

Make the check out to . . . Uncle Sam?

A look at the electronics industry's 1986 taxes shows IBM paid over half the bill. And most of it went abroad

By Anne Knowles and Linda Stallmann

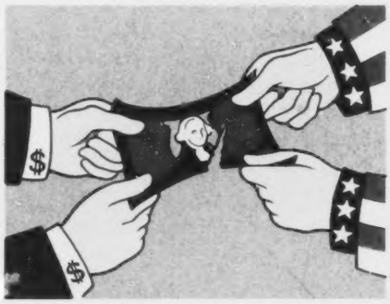
The U.S. electronics industry paid an overwhelming majority of its 1986 tax dollars to foreign governments, according to an ELECTRONIC BUSINESS analysis of income taxes paid by the top U.S. electronics firms. Foreign governments collected $4.7 billion, or 70% of the $6.7 billion total, in taxes from U.S. high-tech companies. In comparison, Uncle Sam raked in a meager $1.5 billion, or 23% of total taxes. The remaining $409 million, or approximately 7% of the total, went to state and local governments.

The analysis is based on data drawn from the ELECTRONIC BUSINESS 200 [July 15, p55], an annual listing of the electronics industry's top 200 companies ranked by revenue. Only those companies from the ELECTRONIC BUSINESS 200 with at least 70% of their total revenue derived from electronics sales were used for a valid comparison. AT&T, General Electric Co., Lockheed Corp. and 72 other electronics makers were excluded and the remaining 125 companies were ranked by total income tax provision or benefit.

IBM paid nearly 95% of its total $3.6 billion provision in foreign taxes. Over 50% of the company's sales and approximately 70% of its earnings before taxes were derived from outside the United States. According to its annual report, IBM's federal taxes were reduced by timing differences relating to sales-type leases and installment sales, lower U.S. net earnings and tax credits, giving the company an effective tax rate of 42.9%.

But Big Blue's influence skewed the scale. Nearly 54% of the industry's $6.7 billion in taxes and almost 73% of its total foreign taxes were paid by IBM, while the Armonk, N.Y., giant doled out only 7% of the total federal taxes. IBM, however, was not the only company paying more abroad. AMP Inc., NCR Corp. and The Perkin-Elmer Corp. were among the companies paying over two-thirds of their taxes to foreign governments. Unisys Corp. and Xerox Corp., for example, both received federal tax benefits while paying $68.5 million and $174 million, respectively, in foreign taxes.

The weighted-average effective tax rate for the industry was 42.9%. Only 21 companies posted rates higher than the federal statutory rate of 46%. Honeywell Inc., for example, paid $26.9 million in taxes on $39.8 million in income, for an effective tax rate of 67.6%. The higher rate resulted primarily from a $44 million revaluation of goodwill in connection with the Minneapolis-based company's $1 billion acquisition of Sperry's Aerospace Group. Distributor Anthem Electronics Inc., microcomputer maker Apple Computer Inc. and peripherals maker Storage Technology Corp. were among the electronics companies paying over 50% of their income in taxes.



The weighted-average effective tax rate for the industry was 42.9%

Tax-cutting tactics

The remaining companies reduced their rates through various tax credits. Digital Equipment Corp., for example, had an effective tax rate of 28%. The company's rate was lowered in part by manufacturing operations in Puerto Rico, Ireland and Singapore, which reduced DEC's tax rate by 12.7%, and investment tax credits, which dropped DEC's rate by 2.8%. Xerox Corp. paid only 16.6% of its income in taxes. The Stamford, Connecticut-based company reduced its tax rate by 3.6% through investment tax credits, another 1.9% with research and development credits and a further 22.2% due to its equity position in its financial services subsidiaries, which include Crum and Forster Inc., Van Kampen Merritt Inc. and Xerox Credit Corp.

While business for semiconductor companies picked up last year, so did their taxes. In 1985, semiconductor companies received a tax benefit of $44.8 million on a combined income loss of $46.3 million. (The list of nine semiconductor companies consists of Advanced Micro Devices Inc., Analog Devices Inc., Intel Corp., LSI Logic Corp., Monolithic Memories Inc., Motorola Inc., National Semiconductor Corp., Texas Instruments Inc. and Western Digital Corp.) Last year, those same manufacturers paid $173.2 million in taxes on aggregate income of $36.7 million. (The sector's high tax-to-income ratio is because some companies made large losses while paying high taxes.)

The Tax Reform Act of 1986, signed last October, had little effect on the industry's taxes, according to company annual reports. Most changes in the law, such as the elimination of the investment tax credit, will not be effective until the 1987 tax year.

Tables follow

Taxes paid by top electronics companies

		Total income tax provision (benefit) ($ millions)			1986 income tax provision (benefit) ($ millions)		
Rank	Company	1986	1985	Percentage change 1986/1985	Federal taxes	State and local taxes	Foreign taxes
1	**IBM**	$3,600.0	$5,064.0	-28.9%	$112.0	$81.0	$3,407.0
2	**GM Hughes Electronics**	366.1	202.0	81.2%	314.3	45.3	6.5
3	**NCR**	283.2	247.6	14.4%	64.7	12.0	206.5
4	**Hewlett-Packard**	264.0	269.0	-1.9%	68.0	29.0	167.0
5	**DEC**	240.1	(15.9)	NM	108.3	18.2	113.6
6	**Tandy**	186.4	162.4	14.8%	158.7	20.9	6.9
7	**Apple Computer**	155.8	58.8	164.9%	124.1	22.9	8.8
8	**AMP**	129.7	84.5	53.4%	30.9	5.3	93.5
9	**Xerox**	112.0	164.9	-32.1%	(60.0)	(2.0)	174.0
10	**Cray Research**	100.4	60.2	66.8%	86.5	10.9	3.0
11	**Pitney Bowes**	93.3	73.4	27.2%	59.8	12.2	21.3
12	**Telex**	72.5	58.2	24.5%	55.4	6.8	10.2
13	**Motorola**	71.0	(27.0)	NM	26.0	6.0	39.0
14	**Texas Instruments**	59.0	3.7	1,494.6%	43.0	0.0	16.0
15	**Intergraph**	53.1	50.8	4.5%	44.1	4.1	4.9
16	**Tandem Computers**	50.7	22.0	130.5%	22.1	7.0	21.6
17	**E-Systems**	47.8	35.7	33.8%	47.3	0.0	0.5
18	**Loral**	41.3	38.2	8.0%	37.0	4.3	0.0
19	**Perkin-Elmer**	39.7	53.8	-26.2%	1.8	1.2	36.7
20	**Medtronic**	34.9	1.1	3,068.5%	17.9	4.6	12.4
21	**Compaq Computer**	31.9	17.2	85.5%	23.6	1.4	6.8
22	**Amdahl**	29.5	11.4	158.8%	22.7	4.7	2.1
23	**Ashton-Tate**	28.1	14.1	98.8%	18.2	5.2	4.7
24	**Honeywell**	26.9	118.6	-77.3%	(4.1)	4.0	27.0
25	**Microsoft**	26.7	18.7	42.6%	NA	NA	NA
26	**Lotus Development**	22.7	29.3	-22.3%	17.0	1.6	4.1
27	**Gould**	22.5	20.9	7.7%	5.2	2.4	14.9
28	**Atari**	22.2	0.0	NM	19.0	1.2	2.0
29	**AST Research**	22.1	19.0	16.4%	15.0	4.1	3.1
30	**Diebold**	21.8	19.4	12.4%	18.8	3.0	—[1]
31	**Molex**	21.3	22.1	-3.6%	3.2	0.8	17.3
32	**N.A. Philips**	20.6	29.7	-30.6%	19.3	1.3	—[1]
33	**Xidex**	20.2	12.8	57.8%	14.8	4.1	1.3
34	**Dynatech**	18.5	15.0	23.1%	13.1	2.0	3.4
35	**Avnet**	18.4	43.7	-57.8%	16.6	1.8	0.0
36	**Storage Technology**	17.7	5.1	248.0%	7.6	1.6	8.5
37	**Prime Computer**	15.6	19.3	-19.0%	12.8	0.8	2.0
38	**Maxtor**	14.6	4.2	246.7%	10.6	3.7	0.3
39	**National Semiconductor**	14.5	17.4	-16.9%	0.5	0.3	13.7
40	**Micropolis**	14.1	0.9	1,533.6%	10.4	2.5	1.2
41	**Digital Communications**	14.0	7.2	94.0%	12.3	1.7	0.0
42	**Gerber Scientific**	13.3	18.8	-29.3%	11.2	1.5	0.6

NA = not available

NM = not meaningful

* Net income or loss before extraordinary items and discontinued operations

[1] Foreign and federal taxes reported together

Effective tax rate		Fiscal 1986 revenue and income ($ millions)			Foreign revenue as a percentage of total revenue	Fiscal year ended	1986 ELECTRONIC BUSINESS 200 rank	Location
1986	1985	Total revenue	Income before taxes	Net income*				
42.9%	43.6%	$51,250.0	$8,389.0	$4,789.0	50.5%	12/86	1	Armonk, N.Y.
45.1%	37.3%	10,440.0	811.2	445.1	12.2%	12/86	4	Detroit, Mich.
45.7%	44.0%	4,881.6	619.7	336.5	43.8%	12/86	14	Dayton, Ohio
33.8%	35.5%	7,102.0	780.0	516.0	46.3%	10/86	8	Palo Alto, Calif.
28.0%	-3.7%	7,590.4	857.5	617.4	41.9%	6/86	5	Maynard, Mass.
48.2%	46.2%	3,035.7	387.0	197.7	2.6%	6/86	19	Fort Worth, Texas
50.3%	49.0%	1,902.0	309.7	154.0	25.8%	9/86	31	Cupertino, Calif.
44.1%	43.9%	1,933.1	294.0	164.3	40.1%	12/86	40	Harrisburg, Pa.
16.6%	27.1%	9,781.0	674.7	488.0	40.4%	12/86	6	Stamford, Conn.
44.6%	44.3%	596.7	225.2	124.8	53.8%	12/86	73	Minneapolis, Minn.
46.3%	43.7%	1,986.7	201.7	166.1	17.3%	12/86	36	Stamford, Conn.
48.2%	46.3%	840.7	150.3	77.5	17.9%	3/87	62	Tulsa, Okla.
26.8%	-60.0%	5,888.0	265.0	194.0	38.2%	12/86	11	Schaumburg, Ill.
59.8%	3.2%	4,974.0	98.7	39.9	25.8%	12/86	13	Dallas, Texas
43.0%	42.8%	605.7	123.5	70.4	34.2%	12/86	72	Huntsville, Ala.
44.3%	39.0%	767.8	114.5	63.8	39.6%	9/86	60	Cupertino, Calif.
43.7%	37.5%	1,145.5	109.3	61.6	6.9%	12/86	51	Dallas, Texas
41.8%	41.9%	690.0	98.7	57.5	6.2%	3/87	68	New York, N.Y.
35.4%	39.6%	1,290.6	112.3	72.6	39.1%	7/86	50	Norwalk, Conn.
32.1%	2.3%	502.0	108.7	73.8	41.5%	4/87	85	Minneapolis, Minn.
41.7%	39.3%	625.2	76.5	42.9	19.1%	12/86	69	Houston, Texas
42.9%	31.8%	966.3	68.8	39.3	43.5%	12/86	52	Sunnyvale, Calif.
48.2%	46.0%	210.8	58.2	30.1	28.2%	1/87	141	Torrance, Calif.
67.6%	30.1%	5,378.2	39.8	12.9	21.7%	12/86	12	Minneapolis, Minn.
40.5%	43.7%	197.5	66.0	39.3	24.0%	6/86	114	Redmond, Wash.
32.0%	43.4%	282.9	71.0	48.3	42.6%	12/86	106	Cambridge, Mass.
39.4%	26.2%	908.8	57.1	34.6	19.3%	12/86	53	Rolling Meadows, Ill.
47.0%	0.0%	258.1	47.2	25.1	53.2%	12/86	115	Sunnyvale, Calif.
44.9%	50.0%	172.3	49.3	27.2	27.8%	6/86	168	Irvine, Calif.
38.4%	38.9%	413.7	56.7	34.9	5.0%	12/86	94	Canton, Ohio
39.7%	41.5%	291.9	53.6	32.0	63.5%	6/86	91	Lisle, Ill.
20.2%	26.7%	4,531.6	101.8	68.5	0.0%	12/86	18	New York, N.Y.
38.5%	33.5%	432.3	52.4	32.2	24.7%	6/86	84	Sunnyvale, Calif.
44.3%	42.3%	304.7	41.7	23.2	25.4%	3/87	105	Burlington, Mass.
43.6%	46.9%	1,415.6	42.3	23.9	0.0%	6/86	47	New York, N.Y.
51.3%	13.3%	696.0	34.6	16.8	20.3%	12/86	67	Louisville, Colo.
25.0%	25.0%	860.2	62.6	46.9	47.2%	12/86	58	Natick, Mass.
39.4%	35.0%	175.3	36.9	26.3	16.0%	3/87	184	San Jose, Calif.
10.8%	33.6%	1,478.1	-133.8	-148.3	37.9%	5/86	39	Santa Clara, Calif.
43.7%	23.8%	213.1	32.4	18.3	17.7%	12/86	138	Chatsworth, Calif.
40.4%	39.9%	137.9	34.6	20.6	17.3%	6/86	176	Alpharette, Ga.
38.9%	43.0%	223.9	34.2	21.1	40.5%	4/87	139	Hartford, Conn.

(Continued)

Taxes paid by top electronics companies (continued)

Rank	Company	Total income tax provision (benefit) ($ millions) 1986	1985	Percentage change 1986/1985	1986 income tax provision (benefit) ($ millions) Federal taxes	State and local taxes	Foreign taxes
43	**Avantek**	$13.3	$12.6	5.5%	$10.6	$2.7	$0.0
44	**UCCEL**	12.9	8.4	54.0%	9.8	0.5	2.5
45	**Watkins-Johnson**	12.7	12.1	5.3%	12.7	0.0	0.1
46	**Ultimate**	12.2	12.8	-4.4%	9.4	1.8	1.0
47	**Altos Computer Systems**	11.2	6.2	81.3%	8.3	2.8	0.1
48	**General Instrument**	11.2[3]	(29.0)	NM	(10.3)	(0.1)	0.1
49	**Marshall Industries**	11.0	5.7	93.0%	8.9	2.1	0.0
50	**Control Data**	10.0	43.7	-77.1%	(16.5)	20.9	5.6
51	**ISC Systems**	9.9	5.5	80.0%	8.6	1.3	0.0
52	**Measurex**	9.8	12.3	-20.3%	4.5	0.9	4.3
53	**Tracor**	9.6	12.3	-22.2%	10.3	(2.9)	2.2
54	**Emerson Radio**	9.4	8.3	13.8%	NA	NA	NA
55	**Sun Microsystems**	9.0	5.7	58.1%	5.8	2.0	1.2
56	**ADC Telecommunications**	9.0	5.0	78.7%	8.0	1.0	0.0
57	**Analogic**	8.7	4.8	81.1%	7.5	0.6	0.6
58	**Analog Devices**	8.7	9.4	-7.9%	0.2	0.2	8.2
59	**Intel**	8.7	(7.0)	NM	(7.9)	0.0	16.5
60	**SCI Systems**	8.5	9.2	-8.3%	NA	NA	NA
61	**Bolt Beranek and Newman**	8.4	6.3	33.1%	8.4	(0.0)	0.0
62	**Datapoint**	8.0	(20.7)	NM	0.8	0.0	7.2
63	**Wyse Technology**	7.9	6.2	28.2%	6.4	1.4	0.2
64	**Electrospace Systems**	7.6	9.9	-22.9%	7.6	0.0	0.0
65	**Genicom**	7.4	1.4	442.7%	6.2	1.1	0.1
66	**Western Digital**	7.2	0.5	1343.0%	2.9	1.5	2.8
67	**BRIntec**	6.8	8.0	-14.7%	3.3	0.9	2.6
68	**Andrew**	6.8	10.5	-34.9%	3.3	0.8	2.7
69	**Singer**	6.8	3.3	106.1%	5.1	0.0	1.7
70	**Logicon**	6.1	9.5	-35.6%	5.1	1.0	0.0
71	**Recognition Equipment**	6.0	2.5	139.6%	1.6	—[4]	4.3
72	**Dynascan**	6.0	0.0	NM	6.0	0.0	0.0
73	**Apollo Computer**	6.0	(12.0)	NM	1.3	0.6	4.1
74	**Mentor Graphics**	5.5	4.1	35.2%	1.9	0.4	3.3
75	**Aydin**	5.2	1.1	373.8%	4.6	0.6	0.0
76	**Wang Laboratories**	5.0	(70.0)	NM	1.9	0.5	2.6
77	**Data General**	4.9	10.9	-54.6%	(4.7)	1.0	8.7
78	**Fluke**	4.8	7.2	-33.9%	4.3	0.0	0.5
79	**Computervision**	4.3	(47.0)	NM	0.0	0.0	4.3
80	**LSI Logic**	4.1	4.7	-12.4%	(0.7)	0.7	4.1
81	**Micom Systems**	3.7	10.4	-64.3%	1.0	1.7	1.1
82	**CTS**	3.5	3.8	-9.1%	(2.2)	3.6	2.0
83	**Decision Industries**	3.4	4.0	-14.3%	0.8	0.7	2.0
84	**Coherent**	3.4	5.2	-34.5%	0.2	0.3	2.9

NA = not available

NM = not meaningful

* Net income or loss before extraordinary items and discontinued operations

[3] $21.5 million allocated to discontinued operations

[4] State taxes included with federal

Effective tax rate		Fiscal 1986 revenue and income ($ millions)			Foreign revenue as a percentage of total revenue	Fiscal year ended	1986 ELECTRONIC BUSINESS 200 rank	Location
1986	1985	Total revenue	Income before taxes	Net income*				
45.2%	41.5%	$208.2	$29.4	$16.1	14.0%	12/86	144	Santa Clara, Calif.
42.8%	41.7%	141.6	30.1	17.2	20.6%	12/86	188	Dallas, Texas
42.5%	39.7%	255.4	30.0	17.2	14.2%	12/86	118	Palo Alto, Calif.
47.0%	47.0%	172.9	26.0	13.8	26.8%	4/87	172	East Hanover, N.J.
35.7%	37.5%	134.2	31.5	20.3	35.0%	6/86	192	San Jose, Calif.
37.7%	-38.2%	787.9	29.7	18.5	16.2%	2/87	57	New York, N.Y.
51.2%	49.9%	245.6	21.5	10.5	0.0%	5/86	109	El Monte, Calif.
3.6%	9.0%	3,346.7	-280.6	-311.1	32.5%	12/86	21	Minneapolis, Minn.
41.7%	40.0%	166.1	23.8	13.9	0.0%	6/86	173	Spokane, Wash.
31.7%	41.0%	192.7	30.9	21.1	51.0%	11/86	152	Cupertino, Calif.
33.7%	39.6%	632.1	28.4	18.8	8.8%	12/86	76	Austin, Texas
26.2%	38.5%	810.1	36.1	26.6	0.0%	3/87	62	Secaucus, N.J.
43.0%	40.1%	210.1	21.0	11.9	20.5%	6/86	93	Mountain View, Calif.
42.9%	39.0%	143.7	21.0	12.0	10.4%	10/86	186	Minneapolis, Minn.
46.3%	33.7%	148.2	18.8	10.1	42.4%	7/86	170	Peabody, Mass.
27.0%	24.0%	334.4	32.1	23.4	47.3%	10/86	95	Norwood, Mass.
5.0%	NM	1,265.0	-174.6	-183.3	39.9%	12/86	48	Santa Clara, Calif.
38.1%	40.2%	470.2	22.3	13.8	21.1%	6/86	80	Huntsville, Ala.
42.7%	42.9%	178.0	19.8	11.3	0.0%	6/86	148	Cambridge, Mass.
NM	-28.8%	325.2	-7.4	-15.4	69.6%	7/86	98	San Antonio, Texas
38.6%	52.0%	166.4	20.5	12.6	13.5%	3/86	131	San Jose, Calif.
43.0%	42.5%	190.7	17.8	10.1	0.0%	3/86	161	Richardson, Texas
46.2%	43.0%	157.5	16.0	8.6	20.1%	12/86	174	Waynesboro, Va.
26.0%	12.1%	279.4	27.8	20.6	33.0%	6/86	89	Irvine, Calif.
36.8%	40.5%	310.7	18.6	11.8	12.4%	12/86	130	Willimantic, Conn.
41.8%	42.7%	197.7	16.4	9.5	32.3%	9/86	147	Orlando Park, Ill.
10.4%	5.5%	1,725.2	65.3	58.5	0.0%	12/86	41	Santa Clara, Calif.
50.2%	48.7%	204.8	12.2	6.1	0.0%	3/87	145	Torrance, Calif.
40.0%	38.4%	241.8	15.0	9.0	46.0%	10/86	124	Irving, Texas
49.5%	0.0%	146.8	12.0	6.1	5.1%	12/86	183	Chicago, Ill.
39.0%	-88.8%	391.7	15.3	9.3	47.8%	12/86	86	Chelmsford, Mass.
33.5%	33.9%	173.5	16.5	11.0	44.0%	12/86	164	Beaverton, Ore.
42.8%	22.1%	136.8	12.2	7.0	28.1%	12/86	196	Horsham, Pa.
8.9%	NM	2,642.5	55.9	50.9	39.7%	6/86	22	Lowell, Mass.
35.0%	31.0%	1,268.0	14.1	5.7	36.4%	9/86	46	Westboro, Mass.
28.1%	32.1%	209.0	16.9	12.2	38.1%	9/86	143	Everett, Wash.
NM	-36.8%	494.7	-1.5	-5.8	29.7%	12/86	79	Bedford, Mass.
48.2%	31.9%	194.3	8.5	3.9	21.2%	12/86	151	Milpitas, Calif.
23.3%	29.3%	196.7	15.9	12.2	25.7%	3/87	154	Simi Valley, Calif.
14.9%	32.1%	245.5	-23.2	-26.6	17.2%	12/86	125	Elkhart, Ind.
30.7%	34.0%	195.1	11.2	7.8	27.0%	11/86	150	Horsham, Pa.
NM	41.2%	138.2	3.4	-0.9	42.7%	9/86	193	Palo Alto, Calif.

(Continued)

Taxes paid by top electronics companies (continued)

Rank	Company	Total income tax provision (benefit) ($ millions) 1986	1985	Percentage change 1986/1985	1986 income tax provision (benefit) ($ millions) Federal taxes	State and local taxes	Foreign taxes
85	**Cipher Data Products**	$3.4	$11.1	-69.7%	$0.5	$0.8	$2.0
86	**TIE/communications**	3.1	(28.5)	NM	2.8	0.7	(0.4)
87	**Tektronix**	3.0	30.3	-90.1%	(17.4)	1.1	19.3
88	**Anthem Electronics**	2.9	3.1	-6.0%	2.4	0.5	0.0
89	**MiniScribe**	2.8	0.4	608.9%	NA	NA	NA
90	**Wyle Laboratories**	2.7	0.7	284.6%	2.6	0.1	0.0
91	**Data Card**	2.6	7.7	-66.5%	2.4	0.5	(0.4)
92	**DSC Communications**	2.4	(15.0)	NM	0.0	2.3	0.1
93	**Tandon**	2.3	(30.7)	NM	0.0	—[5]	2.3
94	**Sun Electric**	2.3	0.5	357.0%	0.2	0.0	2.1
95	**Dataproducts**	2.1	1.2	75.4%	0.1	0.7	1.3
96	**Compugraphic**	1.8	6.7	-72.8%	0.8	0.3	0.7
97	**Seagate Technology**	1.6	(11.3)	NM	(0.4)	2.0	0.0
98	**Intelligent Systems**[2]	1.5	(0.2)	NM	1.3	0.2	0.0
99	**Diasonics**	1.3	3.5	-63.1%	0.0	(0.2)	1.5
100	**Pioneer-Standard**	1.3	(2.0)	NM	1.1	0.2	0.0
101	**Harris**	1.1	19.6	-94.4%	(8.4)	4.6	4.9
102	**Applied Materials**	0.9	6.7	-86.6%	(0.6)	0.1	1.5
103	**Paradyne**	0.8	(2.7)	NM	0.0	0.8	0.1
104	**GenRad**	0.8	(5.1)	NM	0.0	0.3	0.5
105	**Applied Magnetics**	0.8	1.0	-24.8%	0.0	0.2	0.6
106	**Spectra-Physics**	0.7	0.4	73.5%	0.1	0.1	0.4
107	**International Rectifier**	0.7	1.3	-49.2%	0.0	0.0	0.7
108	**Veeco Instruments**	0.2	8.8	-97.4%	(5.1)	(0.5)	5.8
109	**Arrow Electronics**	0.0	(9.1)	NM	0.0	0.0	0.0
110	**Advanced Micro Devices**	0.0	(48.1)	NM	1.5	(0.1)	(1.4)
111	**Monolithic Memories**	0.0	1.6	NM	(1.7)	0.7	1.1
112	**Cubic**	(0.3)	11.0	NM	0.1	(0.4)	0.0
113	**Ducommun**	(0.5)	(3.5)	NM	(0.3)	(0.2)	0.0
114	**AVX**	(1.3)	(10.8)	NM	(1.9)	0.2	0.5
115	**General DataComm Industries**	(2.4)	1.2	NM	(3.8)	0.1	1.3
116	**Kollmorgen**	(2.7)	(12.7)	NM	(3.7)	0.0	1.1
117	**Teradyne**	(2.9)	7.4	NM	(4.1)	1.2	0.0
118	**Unitrode**	(3.0)	5.2	NM	(3.1)	0.2	—[1]
119	**Convergent Technologies**	(3.7)	6.6	NM	(4.0)	0.3	0.0
120	**Augat**	(3.8)	5.1	NM	(6.7)	0.5	2.4
121	**Scientific-Atlanta**	(6.4)	10.9	NM	(5.8)	(0.7)	0.1
122	**Zenith Electronics**	(10.2)	(13.2)	NM	(12.2)	0.3	1.7
123	**M/A-COM**	(16.5)	18.7	NM	(19.4)	1.8	1.1
124	**Varian Associates**	(25.3)	17.1	NM	(29.9)	0.2	4.4
125	**Unisys**	(48.4)	111.3	NM	(116.9)	0.0	68.5
	TOTAL	**$6,698.6**			**$1,535.4**	**$408.8**	**$4,685.5**

NA = not available

NM = not meaningful

* Net income or loss before extraordinary items and discontinued operations

[1] Foreign and federal taxes reported together

[2] Data for nine months due to change in fiscal year from March to December

[5] State taxes included with foreign

Effective tax rate		Fiscal 1986 revenue and income ($ millions)			Foreign revenue as a percentage of total revenue	Fiscal year ended	1986 ELECTRONIC BUSINESS 200 rank	Location
1986	1985	Total revenue	Income before taxes	Net income*				
31.9%	43.0%	163.0	10.6	7.2	30.9%	6/86	160	San Diego, Calif.
5.6%	-27.9%	298.2	-55.5	-59.3	25.7%	12/86	103	Shelton, Conn.
7.1%	25.1%	1,352.2	42.3	39.3	38.8%	5/86	44	Beaverton, Ore.
52.0%	49.9%	148.9	5.6	2.7	0.0%	3/87	198	San Jose, Calif.
12.1%	2.4%	184.9	23.1	20.3	22.0%	12/86	158	Longmont, Colo.
38.5%	32.4%	307.0	7.0	4.3	0.0%	1/87	134	El Segundo, Calif.
61.4%	41.7%	176.1	4.2	1.6	28.0%	3/87	175	Minneapolis, Minn.
17.8%	-23.2%	304.0	13.4	11.0	0.0%	12/86	102	Plano, Texas
3.8%	-18.5%	214.1	-60.5	-62.8	69.4%	9/86	127	Chatsworth, Calif.
62.4%	5.4%	177.0	3.7	1.4	31.5%	10/86	169	Crystal Lake, Ill.
19.0%	4.0%	338.8	11.1	9.0	26.8%	3/87	90	Woodland Hills, Calif.
35.0%	23.4%	341.1	5.2	3.4	24.8%	12/86	92	Wilmington, Mass.
4.4%	NM	459.8	36.1	34.5	36.7%	6/86	66	Scotts Valley, Calif.
61.8%	NM	108.4	2.4	0.7	21.4%	12/86	187	Norcross, Ga.
8.0%	48.2%	217.1	-16.1	-17.4	26.0%	12/86	136	Milpitas, Calif.
40.9%	-49.4%	212.2	3.1	1.8	0.0%	3/87	137	Cleveland, Ohio
1.8%	19.7%	2,239.9	60.7	59.6	6.9%	6/86	29	Melbourne, Fla.
42.0%	42.0%	149.3	2.1	1.2	53.5%	10/86	178	Santa Clara, Calif.
2.2%	-8.1%	261.1	-37.6	-38.5	11.0%	12/86	112	Largo, Fla.
2.6%	-8.9%	204.3	-29.1	-29.9	42.4%	12/86	146	Concord, Mass.
15.6%	49.4%	128.1	4.9	4.1	33.9%	9/86	194	Goleta, Calif.
45.0%	11.0%	210.1	1.5	0.8	48.1%	9/86	142	San Jose, Calif.
60.6%	15.9%	145.2	-1.1	-1.8	46.4%	6/86	177	Los Angeles, Calif.
13.0%	46.6%	167.8	1.8	0.4	44.0%	9/86	166	Melville, N.Y.
0.0%	45.6%	529.6	-28.3	-28.3	0.0%	12/86	78	Farmingdale, N.Y.
0.0%	-56.8%	632.0	-95.9	-95.9	24.4%	3/87	71	Sunnyvale, Calif.
0.0%	13.4%	204.9	8.9	8.9	26.2%	9/86	140	Santa Clara, Calif.
-33.5%	42.9%	341.9	0.8	1.1	0.0%	9/86	97	San Diego, Calif.
-2.5%	-51.7%	455.2	-19.7	-19.2	0.0%	12/86	87	Los Angeles, Calif.
-29.2%	-46.9%	195.4	-4.4	-3.1	34.7%	12/86	149	Great Neck, N.Y.
NM	10.1%	178.0	1.5	3.9	23.2%	9/86	156	Middlebury, Conn.
-11.8%	-66.7%	319.2	-22.6	-19.9	7.7%	12/86	107	Hartford, Conn.
NM	26.7%	306.1	-2.7	0.2	34.0%	12/86	100	Boston, Mass.
-29.7%	36.0%	149.4	-10.0	-7.0	20.0%	1/87	182	Lexington, Mass.
-10.1%	36.5%	305.8	-36.5	-32.8	14.0%	12/86	101	San Jose, Calif.
-30.3%	29.6%	260.3	-12.5	-8.7	18.5%	12/86	113	Mansfield, Mass.
-41.0%	40.0%	469.1	-15.6	-9.2	16.0%	6/86	81	Atlanta, Ga.
-50.5%	-63.2%	1,892.1	-20.2	-10.0	12.0%	12/86	34	Glenview, Ill.
-42.6%	31.0%	577.5	-38.7	-22.2	10.2%	9/86	75	Burlington, Mass.
-63.0%	30.0%	891.1	-40.2	-14.9	22.8%	9/86	56	Palo Alto, Calif.
-52.7%	31.0%	7,432.4	-91.8	-43.4	42.9%	12/86	7	Detroit, Mich.
42.7%		**$181,101.4**	**$15,682.1**	**$8,925.2**				
Weighted average								

Source: ELECTRONIC BUSINESS

COMMUNICATIONS

Calling all computers: The modem race is on

Everyone agrees that sales of fast modems are hot. Too bad they can't agree on standards

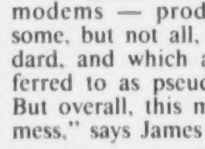
Desktop computers are gaining in power and might, processing information faster than ever before. This, in turn, is pushing demand for high-speed, "dial-up" modems that send and receive data over public telephone lines at speeds of 9,600 bits per second (bps) and faster.

Currently, U.S. shipments of 9,600 bps modems are valued at $371 million and are forecast to grow at a rate of 11.5% this year and an additional 13.5% during 1988, according to research firm International Data Corp. (IDC) in Framingham, Mass. By 1991 the market should hit $600 million.

Despite this rosy picture, confusion reigns in the marketplace as vendors bicker over the V.32 standard that defines how a hotshot modem simultaneously sends and receives data at 9,600 bps. Sticking to this standard is technologically complex and expensive — one source says it calls for the processing power of two IBM PC ATs — and this has led to a major schism in suppliers' ranks.

Some companies, like Anderson-Jacobson Inc., AT&T and Concord Data Systems Inc., have opted to follow the V.32 definitions laid down by the Consultative Committee for International Telegraphy and Telephony (CCITT), the advisory committee that recommends worldwide standards for communications equipment and common carrier services.

But others, like Hayes Microcomputer Products Inc., MicroCom Inc., the Racal-Vadic unit of Racal Electronics Plc and USRobotics, have developed their own versions of V.32 modems — products that follow some, but not all, of the V.32 standard, and which are sometimes referred to as pseudo-V.32 products. But overall, this market "really is a mess," says James Jordan, president of Telebit Corp., a Cupertino, Calif., company which has its own version of a 9,600 bps, dial-up modem that is neither true V.32 nor pseudo V.32.



However, even though there now appears to be a split between the "true" and "pseudo" factions, it is expected that they will eventually merge as the market matures.

Meanwhile, as long as the true V.32 modems remain pricey — currently averaging $2,400 per unit — their sales will remain limited to applications where cost is secondary to performance, suggests Lawrence Cynar, an analyst at research firm Dataquest in San Jose. It's tough to get someone to spend a few thousand dollars on a modem, he adds, when they haven't spent much more than that on their computers. Testimony to that comes from IDC analyst Richard Villars, who points out that during 1986 — the first year that vendors began to ship the speedy modems in volume — less than 6,000 true V.32 units were sold.

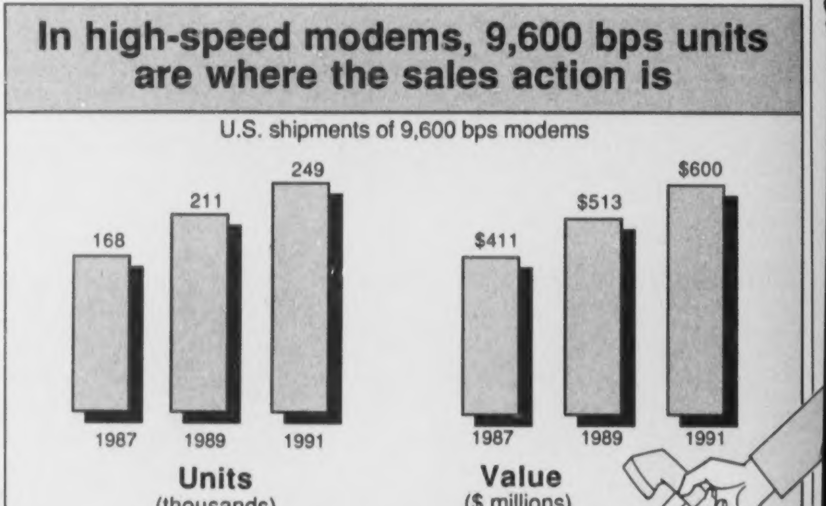
True-blue V.32 vendors have an answer for that. "V.32 technology is still relatively young," argues Kenneth Miller, chairman of Concord Data Systems of Marlborough, Mass. In time, Miller points out, prices will fall and applications for these products will increase. Already, Concord Data is moving in that direction. This September, the company — which Miller claims currently holds 70% of the V.32 market — announced the first true V.32 product that will sell for under $2,000.

This is bound to create insomnia for other true-blue V.32 vendors — like Anderson-Jacobson, British Telecommunications Plc, and Motorola Inc. subsidiaries Codex Corp. and Universal Data Systems.

Concord Data's pricing initiative is less likely to worry the manufacturers that have opted to skirt some or all of the standards to make less costly modems with more mass appeal. One such player is Telebit, which entered the high-speed market two years ago with its own proprietary protocols and which, president James Jordan claims, has an installed base of 10,000 units.

In a push to have its technology established as the industry's de facto standard, Telebit has a technology licensing agreement with Ventel Corp., the second-largest 2,400 bps modem manufacturer in the United States. Telebit also wants to establish more of these ties with overseas companies, says Jordan.

Telebit's technology and that of USRobotics are being considered by the CCITT as possible standards for


In high-speed modems, 9,600 bps units are where the sales action is

U.S. shipments of 9,600 bps modems

Source: International Data Corp.

the lower end of the high-speed dial-up market. Like Telebit, USRobotics, based in Skokie, Ill., is aggressively pursuing licensing deals and private-label contracts in hopes of having its technology deemed the de facto standard. So far, USRobotics — which also boasts an installed base of 10,000 units — has signed a licensing agreement with Data Race Inc., in San Antonio, Texas.

One of the newest entrants in the pseudo-V.32 arena is Hayes, from Norcross, Ga. This past summer, Hayes introduced its version of a 9,600 bps dial-up modem and is hoping to repeat the success it has achieved in the lower-speed modem market. IDC says that Hayes is the leader in both 1,200 bps and 2,400 bps full-duplex modem sectors. (Full duplex is the term applied to modems that send and receive data at the same speed.)

Although these vendors are hoping for broad market acceptance, Miller, of Concord Data, believes that "they're all going to die and wither on the vine." As far as the CCITT accepting either the Telebit or USRobotics technology, a number of industry players, including Jordan of Telebit, believe that there will be no change in the near future.

Another fly in the ointment could be the availability of V.32 chip sets, which could spur price competition and lower the entry barriers for potential newcomers to the true V.32 modem market. Currently, many vendors are using commercial digital-signal processors, including Texas Instrument Inc.'s TMS 320 family, and are doing a lot of value-added work. The availability of a true V.32 chip set "could get that market going," says Cynar, of Dataquest.

That day might be close. Several semiconductor manufacturers — including Rockwell International Corp.'s Semiconductor Products Division and TI — are expected to be selling V.32 chip sets soon.

CAROL SUBY

DEFENSE ELECTRONICS

Tempting manufacturers to "Tempestize"

The market for secure military systems based on the NSA's secret specifications should hit $1 billion this year

Washington thrives on secrecy. As everyone knows by now, shredders work nonstop in the nation's capital to destroy classified papers. What's more difficult, however, is keeping electronic messages from getting into the wrong hands. Indeed, not too long ago, an electrical engineer was able to pick up and decipher electromagnetic radiation emissions from a terminal — using just a standard television, $12 worth of Radio Shack parts and rabbit ear antennas.

Not surprisingly, this worries government officials. If low-tech rabbit ears can retrieve emanations, just imagine what large, sophisticated antennas perched on nearby embassies — or in satellites flying overhead — can pick up. Even though no one knows just how serious a threat electronic eavesdropping is to national security, government agencies are taking no chances.

Increasingly, defense agencies, military units and contractors are required to use National Security Agency-approved Tempest products designed to prevent spies from picking up radio frequency and electromagnetic emanations from information-processing equipment.

As a result, sales of Tempest military products are expected to rise almost 28% to $1.12 billion this year, from $874 million last year, according to Frost & Sullivan Inc. By 1992, projects the New York City market research firm, the market will reach $2.93 billion. As more Tempest products are absorbed into the installed base, however, the growth rate may slow to the rate for information technology products as a whole — about 7% annually, says Frost & Sullivan in its recent analysis of the Tempest market.

But, for the time being, manufacturers of Tempest products remain optimistic. "We're doing very well," says David Barry, marketing manager for Tempest systems at Wang Laboratories Inc. "The market continues to expand." Wang, based in Lowell, Mass., is the Tempest leader, with a 21% share, according to International Resource Development Inc. (IRD), a Norwalk, Conn., research firm. IBM is second, with 11% of the market. "IBM is playing catch-up to Wang, which got in early and for several years has dominated the market both in terms of listed products and sales," states a recent IRD report on Tempest. "Digital Equipment Corp. in turn will be pursuing IBM." Systematics General Corp., a unit of Atlantic Research Corp. of Alexandria, Va., is third, with a 9% share, according to IRD.

> Sales of Tempest military products are expected to rise almost 28% to $1.12 billion this year

Tempest products include secure personal computers, workstations, associated peripherals and local area networks. The fastest-growing segment is secure telephones. "In addition to the equipment market," states the IRD report, "there are thriving businesses in components such as cables and connectors . . . and integration of Tempest units into complete systems . . . ." Amphenol Products and ITT Cannon reportedly are big suppliers of connectors for Tempest equipment. The specific requirements of Tempest products are available only to members of the Industrial Tempest Program, which is under the jurisdiction of the super-secret National Security Agency. Technical standards are detailed in NACSIM 5100A.

Tempest is shrouded in secrecy. At one time, it was illegal to even mention the program by name. "Tempest" was a code word for electronic eavesdropping — and it was classified. This policy has been relaxed. Now, suppliers and users can mention the word, but not much else. Vendors must sign an agreement that makes it illegal for them to discuss what technology or materials they use to "Tempestize" their products.

Even though it's difficult to penetrate the veil of secrecy, leaks provide some insight into what makes products unique. Originally, Tempest-shielding was applied to entire computer rooms, which were constructed like huge vaults. Now it is applied to individual units as well. Metal enclosures, wire gauze and — increasingly — elastomers (conductive plastics) are used to absorb emissions from information-processing equipment. Also, insulated connectors, filter networks for conductors and capacitors, tube shields and wire wraps offer protection. "Wire mesh screen, metal and other conductive gaskets, metal honeycombs and tubes with small openings are able to provide good shielding continuity while permitting cable penetration, letting air or light pass or sealing doors shut," states the IRD report.

Fiber-optic technology, meanwhile, is making it easier to protect secure communications from being intercepted. "Fiber optics enables you to transmit information via light, not electrical signals," points out J.C. Cummings, president of Molex Inc.'s Switch Products Division. "There is no leakage and no interference with adjacent components." IRD agrees. "In principle, an all-optical computer would be ideal for Tempest security," states the report. "But this is still more than 10 years off."

Some companies use a technique called "source suppression," which involves altering printed circuit boards and semiconductors to suppress signals that might easily be picked up. Also, special chips can be built into Tempest computers or peripherals to generate programs that run simultaneously to the program that the computer is running. This technique generates enough noise to scramble signals and deter electronic eavesdropping.

But most prefer simpler approaches, such as shielding the products. "Shielding sounds simple, but it isn't," says Stephen Hines, director of marketing for Atlantic Research's Tempest Division. "The quality of engineering of the Tempest solution is more important than anything else." Atlantic Research adapts other computer maker's products to meet Tempest standards. It also puts together customized systems and tests Tempest products.

> The specific requirements of Tempest products are available only to members of the Industrial Tempest Program

In some cases, installations that process classifed information go so far as to shield entire facilities. Shielded buildings — constructed with metal just inside their frames — have been erected by such government agencies as the Federal Bureau of Investigation and the Central Intelligence Agency. And General Electric Co.'s Federal Electronic Systems Division reportedly is building a large shielded complex in Reston, Va., which will will be used for computer research.

Increasingly, government contractors are being forced to Tempestize their facilities, through shielding and/or expanded use of Tempest products. And, some say, an increasing number of private companies are showing interest in Tempest computers and peripherals, as well. Banks and financial institutions, for example, are concerned that confidential transactions and trade secrets can be retrieved and decoded by enterprising industrial spies. Such illegal snooping could be especially detrimental to financial institutions.

Still, commercial applications to date remain minimal. "There's a certain amount of jawboning about what the commercial sector might do in the future," says Kenneth Bosomworth, IRD president. "We do see some moves toward data security in the *Fortune* 500 firms, but, generally, there hasn't been much in the way of orders yet."

Most manufacturers of computers and peripherals are getting into Tempest — if they're not already major players. Participation in the Industrial Tempest Program is becoming essential to large defense contractors. "Major procurements of information systems products can encompass a bulk purchase of a product involving a mix of the commercial version and the Tempest version of the product," notes Frost & Sullivan. "If a supplier is unable to offer a Tempest accredited version of its commercial products, the company may be disqualified from the entire procurement."

As Tempest sales climb, meanwhile, the price differential is narrowing between commercial and secure versions of the same product. "There's now about a 40% premium for Tempest, compared with 75% five years ago," says Wang's Barry. "And the price will continue to drop."

BETH KARLIN

Military Tempest equipment market

By end-user ($ millions)

	1986	1987	1992
Air Force	$219	$279	$734
Army	114	145	382
Contractors	226	290	762
Defense agencies	149	190	499
Navy/Marines	166	212	558
Total	**$874**	**$1,116**	**$2,935**

By product ($ millions)

	1986	1987	1992
Minis and multiuser	$254	$330	$827
Network equipment	82	100	236
PCs and workstations	231	300	752
Secure telephones	80	90	400
Tempest services	40	53	111
Terminals and printers	187	243	609
Total	**$874**	**$1,116**	**$2,935**

Source: Frost and Sullivan Inc.